EXPLORING THE UNDERREPRESENTATION OF FEMALE STUDENTS IN ENGINEERING STUDIES AT A TVET COLLEGE

SUBMITTED BY:

Full names: LUCIA GERALDINE HARMSE

Student no: 53024397

Submitted in partial fulfilment for the requirement for the degree of

MASTER OF EDUCATION - ADULT EDUCATION

at the

UNIVERSITY OF SOUTH AFRICA

Supervisor: PROFESSOR N. ROMM

JANUARY 2021

DECLARATION

Student number: 53024397

I declare that “Exploring the underrepresentation of female students in engineering studies at a TVET college" is my own work and that the sources that I have used or quoted have been indicated and acknowledged through complete references.

Lucia Harmse

January 2021

ACKNOWLEDGEMENTS

I would like to firstly thank God for his grace, his wisdom, guidance, and strength that he gave me as I undertook this journey to complete my study. Enlightenment that I discovered on this path allowed for renewal in me, and for that, I will always be grateful.

I thank God for placing a remarkable mentor on my path, to whom I could look up to. Thank you, Prof Romm, for your patient guidance, profound wisdom, gentle encouragement, and example of excellence I can only strive for. Special thanks to Prof Lemmer for assisting with the language editing.

To my family, who have given me all their support and love in ways that can never be measured, I say thank you. None of this would have been possible if I didn't have you, Mom and Dad, as amazing parents and my supportive brother who always believed I can accomplish anything, even the impossible. Finally, thanks to the light of my life, my inspiration … my darling son, Luquen.

ABSTRACT

The study explored women's underrepresentation in engineering at a Technical Vocational and Education and Training (TVET) College in Gauteng, South Africa. Research on the lack of women in engineering exists, however, the underrepresentation of women students in engineering at TVET Colleges is under-researched. Using a theoretical starting point Bandura's concept of self-efficacy, a qualitative study explored views of selected female students on female underrepresentation in engineering at TVET Colleges, with reference to South West Gauteng College. Interviews with women in Engineering, Business Studies and Hospitality courses were undertaken. Findings indicated: engineering students' desire for equal career opportunities in engineering; recognition of the impact of gender stereotypes and differing ways of developing self-efficacy and capabilities as women to follow an engineering career; the barrier of gender stereotypes on secondary school girls' choice of and achievement in Mathematics and Science and the information gap concerning career options in engineering; as well as benefits provided by TVET Colleges offering these courses. Some recommendations which are suggested are: TVET Colleges should ensure that more information about the engineering courses offered at these institutions be relayed to the public in a manner that is inclusive to everyone irrespective of gender.

Key words: engineering-related studies, self-efficacy, TVET Colleges, gender stereotypes, equality, artisans

TABLE OF CONTENTS

DECLARATION
ACKNOWLEDGEMENTS
ABSTRACT
TABLE OF CONTENTS
LIST OF TABLES
LIST OF ABBREVIATIONS

CHAPTER 1

ORIENTATION TO STUDY

1.1 INTRODUCTION AND BACKGROUND 1
1.2 THE RATIONALE FOR THE STUDY 3
1.3 STATEMENT OF THE PROBLEM 4
1.3.1 The research questions 4
1.3.2 The aim and objectives of the study 4
1.4 RESEARCH DESIGN AND METHODOLOGY 5
1.4.1 Research paradigm 5
1.4.2 Research approach and design 5
1.4.3 Sampling 5
1.4.4 Instruments and data collection techniques 6
1.4.5 Data analysis and interpretation 6
1.5 ISSUES OF CREDIBILITY 7
1.6 ETHICAL CONSIDERATIONS 8
1.7 LIMITATIONS AND DELIMITATIONS OF THE STUDY 8
1.8 CLARIFICATION OF TERMS 9
1.9 ORGANISATION OF THE DISSERTATION 10
1.10 CONCLUSION 11

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION 12
2.2 WOMEN IN ENGINEERING STUDIES 12
2.2.1 Introduction 12
2.2.2 Background of female participation in engineering studies worldwide 13
2.3 GENDER ROLE IMPLICATIONS AND THE THEORIES DRAWN UPON 13
2.3.1 Male and female gender role implications 13
2.3.2 Self-efficacy theory 15
2.3.2.1 What is the self-efficacy theory? 15
2.3.2.2 Impact of self-efficacy theory 16
2.3.2.3 Does gender play a role in self-efficacy? 17
2.3.3 Gender Stereotyping 21
2.3.3.1 What is gender stereotyping? 21
2.3.3.2 Implications of gender stereotyping 22
2.3.3.3 Gender stereotyping at the school level 23
2.3.3.4 How to combat stereotypes 24
2.4 ROLE OF TVET COLLEGES IN SOUTH AFRICA 26
2.4.1 What are TVET Colleges? 26
2.4.2 NCV Programme 27
2.4.3 Social barriers for students redirecting them to TVET Colleges. 27
2.5 CONCLUSION 29

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION 30
3.2 RESEARCH PARADIGM 30
3.3 RESEARCH APPROACH 30
3.4 RESEARCH DESIGN 31
3.5 SAMPLING 33
3.6 PARTICIPANTS 34
3.7 INSTRUMENTS AND DATA COLLECTION TECHNIQUES 35
3.8 DATA ANALYSIS AND INTERPRETATION 35
3.9 ISSUES OF CREDIBILITY 37
3.10 ETHICAL CONSIDERATIONS 38
3.11 LIMITATIONS AND DELIMITATIONS OF THE STUDY 38
3.12 CONCLUSION 39

CHAPTER 4
RESULTS AND ANALYSIS

4.1 INTRODUCTION 40
4.2 DATA ANALYSIS AND INTERPRETATION 40
4.3 RESULTS 42
4.3.1 Desire for equality in the engineering career path 45
4.3.2 Stereotypes 47
4.3.2.1 Stereotypes experienced by engineering students **47**
4.3.2.2 The view on stereotypes from the perspective of Business Studies and Hospitality participants **50**
4.3.2.3 Stereotypes and effect on capabilities **51**
4.3.2.4 Age as a factor in developing self-confidence **54**
4.3.3 Self-efficacy 56

4.3.3.1 Self-efficacy explored amongst the engineering participants 56

4.3.3.2 Development of a sense of capabilities 59

4.3.3.3 Self-efficacy explored among participants who study Business Studies 62

4.3.3.4 Self-efficacy explored amongst the Hospitality students 64

4.3.4 Lack of information or education 68

4.3.5 Influence of Mathematics and Science marks of learners at TVET Colleges 71

4.3.6 NCV as a practical course..... 72

4.3.6.1 NCV course and the provision of Basics.....73

4.3.6.2 Practical aspect provided by NCV course 74

4.3.6.3 NCV – A year course 75

4.3.6.4 Minimum requirements for NATED Courses not met 76

4.4 CONCLUSION..... 76

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION 78

5.2 WHAT TRIGGERED THE ENROLMENT OF FEMALE STUDENTS FOR ENGINEERING STUDIES AT THE TVET COLLEGE?..... 78

5.2.1 Desire for equality in the engineering career path 79

5.2.2 Lack of information or education..... 79

5.2.3 Self-efficacy 80

5.2.4 Influence of Mathematics and Science marks at TVET Colleges 80

5.3 WHAT WERE THE REASONS FOR FEMALE STUDENTS TO ENROL IN OTHER COURSES BESIDES ENGINEERING STUDIES AT THE TVET COLLEGE? 81

5.3.1 Influence of Mathematics and Science..... 81

5.3.2 Stereotypes..... 81

5.3.3 Lack of information or education 82

5.4 WHY DID THE FEMALE ENGINEERING STUDENTS ENROL IN THE NCV PROGRAMME? 82

5.4.1 Influence of Mathematics and Science marks at TVET Colleges 82

5.4.2 Practical aspect of NCV 82

5.4.3. Lack of information or education 83

5.5 DID THESE ENGINEERING STUDENTS FEEL THAT THEY HAD TO OVERCOME SOCIAL OBSTACLES WHEN DECIDING TO ENROL IN THE NCV PROGRAMME? 83

5.5.1. Desire for equality in the engineering career path 83

5.5.2. Stereotypes 83

5.5.3 Lack of information or education 84

5.5.4 Practical aspect of NCV 84

5.6 RECOMMENDATIONS TO ATTRACT WOMEN TO STUDY ENGINEERING AT TVET COLLEGES 85

5.6.1 Desire for equality in the engineering pathway 85

5.6.2 Stereotypes 85

5.6.3 Lack of information or education 86

5.7 CONCLUSION 87

REFERENCES

6 REFERENCES 88

APPENDIX A 100

APPENDIX B 105

LIST OF TABLES

Table 3.1: Participants in the study and their fields of study 34

Table 4.1: Themes that emerged from the data collected and analysed 45

LIST OF ABBREVIATIONS

DHET	Department of Higher Education and Training
NATED	National Accredited Technical Education Diploma
NCV	National Certificate Vocational
NQF	National Qualifications Framework
STEM	Science, Technology, Engineering and Mathematics
TVET	Technical and Vocational Educational Training
SWGC	South West Gauteng College
UNESCO	United Nations, Educational, Scientific and Cultural Organisation

CHAPTER 1
ORIENTATION TO THE STUDY

1.1 Introduction and background

Governments around the world indicate an increased interest in producing more engineers and in promoting the interest in engineering studies among the youth. This is done because the prosperity of a country is dependent on its highly skilled workforce as indicated by Gill, Sharp, Mills, and Franzway (2008:3). Studies in science and technology have been targeted as priority areas for development in South Africa (Mathews, Glencross & Kentane, 2000:160) as it is important for the economic growth of any country to supply future scientists and engineers who can be active citizens in a scientifically advancing global society (Archer, Dawson, DeWitt, Seakins & Wong, 2015:923).

However, the disproportionate underrepresentation of women in the engineering faculties and workplaces continues to be a problem in many countries as indicated by Bastalich, Franzway, Gill, Mills, and Sharp (2007:385). They also claim that women engineers tend to drop out of the profession in higher numbers than their male counterparts. If there are more women in the engineering fields Fox, Sonnet and Nikiforova (2009:334) suggest that firstly it would challenge the principle of social equity, expressed in the belief that scientific careers should be "open to talent" and not constrained by factors such as race and gender; and secondly, it would tap into the potential contribution of women to the size, creativity, and diversity of the scientific and engineering workforce.

This research is focused on engineering studies and the reasons why women are not readily attracted to consider a career in the engineering discipline. Much research has been conducted concerning the lack of women in the engineering workplace (Hatmaker, 2013; Herman, 2015; Ranson, 2005; UNESCO, 2015). Engineering faculties in many universities have also been researched, scrutinising the reasons why female students are underrepresented in the engineering disciplines and their inability to complete studies in these courses (Graham, 1997; Gumpertz, Durodoye, Griffith & Willson, 2017; Milgram, 2011; Savaria & Monteiro, 2017). However, limited research has been conducted on the underrepresentation

of female students in engineering studies at Technical Vocational and Educational Training (TVET) Colleges (Foster, 2005). This particular investigation offers a parallel contribution to existing research in some respects but seeks to delve into the reasons for a lack of female learners compared to their male counterparts in the engineering discipline at TVET colleges.

For this study, South West Gauteng College (SWGC) is targeted as this is where I have observed the disproportionate enrolment of women against their male counterparts at one of the engineering campuses where I am based. According to the statistics retrieved from SWGC, 573 female students were enrolled for National Certificate Vocational (NCV) level engineering courses available at the college as opposed to the 1502 male students who were enrolled for these courses in 2016. In the same year, 3724 female students enrolled for engineering courses offered at the National Accredited Technical Education Diploma (NATED) (N1-N6) level at this college compared to the 5465 male students who enrolled for these courses.

Foster (2005) explores some of the barriers to women's choice of science and engineering fields at TVET colleges. Foster's research focuses on N4-N6 engineering courses that are offered at TVET colleges. A gap in research exists at NCV level engineering courses. For this reason, female students that are currently doing engineering studies on the NCV level are the targeted sample and contrasted with the female students studying hospitality and business studies at the NCV level.

At present, South Africa has a high unemployment rate of 30.8% according to Stats SA (2020), and the legacy of apartheid has left a scar of inequality among the skilled labour workforce that should be advancing its economy (Gewer, 2009). TVET Colleges have been tasked to award previously disadvantaged students the opportunity to equip themselves with skills to enter the South African workforce. Apprenticeship training in engineering can be dated back to the 1880s during the industrialisation of the country through mining and the railway works (Mbanguto, 2002:39). Mbanguto (2002) further indicates that this type of training was aimed at the transfer of technical skills or 'on the job' training with some theoretical knowledge needed for the trade. TVET Colleges currently offer engineering artisan training programmes as NATED courses at levels N1 – N6; these courses are

theoretical in nature and offered as trimester courses. To obtain a national diploma upon completion of the N6 module, learners need 18 months of experiential training (Department of Education [DOE], 2000/03).

However, in 2007 the NCV qualification was introduced to compensate for the lack of practical work experience in the NATED courses offered at these colleges. According to the Government Gazette, released by the DOE on 29 March 2006, the vocational component ensures that the qualification is specific. "It involves learning experiences in situations contextually relevant to the particular vocational". This vocational component also allows for the attainment of specific learning that is needed for specialisation in a certain programme. The NCV courses are offered as year courses, NQF levels 2, 3, and 4 were introduced to replace the N1-N3 trimesters. Upon completion of the NCV course, learners can also gain access to universities with a technical background as an advantage as indicated by Pandor (DOE, 2007). This investigation focuses on the NCV engineering course.

1.2 The rationale for the study

According to Nzimande (2013), one of the biggest priorities in South Africa is to develop qualified artisans to support the economy and to deal with the shortage of critical skills in the country (Akojee, Gonon, Hauschildt & Hofmann, 2013:1). Given the dearth of skills in this field, a greater chance of employment can be ensured for individuals with the relevant skills, especially in our country with its high unemployment rate. Graham (1997:4) states that women in traditionally male-dominated fields such as engineering-related fields tend to earn more than their counterparts in traditionally female-dominated fields. It is therefore important to explore the reasons why so few women are interested in studying engineering-related courses at TVET Colleges. I explore this in this study with special reference to a selected TVET College in Gauteng.

1.3 Statement of the problem

This investigation aims to explore the reasons why female students are underrepresented in engineering studies at TVET Colleges, with special reference to a selected TVET College in Gauteng. The research problem derives from the fact that female students' conceptions of their self-efficacy in the light of stereotypical views of women's capabilities have been under researched.

1.3.1 The research questions

The main research question is formulated as follows: What are some of the reasons for the underrepresentation of female students in engineering studies at TVET Colleges?

The following sub-questions assist in exploring the main research question:

- What triggered the enrolment of female students for engineering studies at the TVET College?
- What were the reasons for female students to enrol in other courses besides engineering studies at the TVET College?
- Why did the female engineering students enrol in the NCV programme?
- Did these engineering students feel that they had to overcome social obstacles when deciding to enrol in the NCV programme?

1.3.2 The aim and objectives of the study

The study aims to explore some of the reasons for the underrepresentation of female students in engineering studies at TVET Colleges.

In an attempt to achieve this aim, the objectives for this investigation are as follows:

- To explore with participants what triggered the enrolment of female students in engineering studies at the TVET College;
- To investigate the reasons why female students do not enrol in engineering studies at the TVET college;
- To explore the reasons why the female engineering students chose to enrol in the NCV programme;

- To explore any felt obstacles when deciding to enrol in the NCV programme.

1.4 Research design and methodology

1.4.1 Research paradigm

The constructivist paradigm, is the research paradigm that was chosen for this study. According to McMillan and Schumacher (2010:347), the constructivist design focuses on the feelings, beliefs, and the perspectives that the participants hold that have developed and expressed their insights. This paradigm is appropriate as the investigation seeks to understand the social phenomenon concerning the underrepresentation of female engineering students at TVET Colleges. Within this study, gender-stereotypes and their effects (or not) on the capabilities or beliefs concerning their capabilities are also reflected upon. Within this paradigm, my perspective is also considered in the interpretation of collected data as it is understood that researchers also construct interpretations as they engage with "the data" (Lincoln & Guba, 2013:70)

1.4.2 Research approach and design

The research approach chosen for this study is a qualitative research approach, which relied on collecting and interpreting qualitative data from interviews conducted with the participants. According to Guba and Lincoln (1994:105) constructivist epistemology focuses on participants and how they construct social phenomena with the researcher (within the research context).

A phenomenological approach was the type of design chosen for this study. A phenomenological study is one that aims to describe the meaning of a lived experience as people reflect together on its meaning, as part of making sense of a particular experience or situation (McMillan & Schumacher, 2010:24).

1.4.3 Sampling

According to Lodico, Spaulding and Voegtle (2006:140), In qualitative research, researchers choose a sample based on the characteristics that the participants display and the knowledge that they are considered to possess concerning the investigation in their natural context. This study took place at TVET College where

I am currently employed, after noticing the disproportionate enrolment of men versus women within the engineering courses offered at this college. Within this study, six female engineering students formed part of this study, three female business studies students and finally three female hospitality students also formed part of this study. All of these participants were enrolled for the NCV course (Level 2). The rationale for selection was based on my being able to compare the experiences/understandings of female students studying engineering with those studying other courses, with reference to the topic under investigation (the underrepresentation of female students in engineering). The details of how the participants became selected are explained in Section 5 of Chapter 3 (3.5).

1.4.4 Instruments and data collection techniques

The conducting of in-depth interviews was the method of data collection with the chosen sample. This was done through one-on one interviews with the participants. Before I started the interviews, I explained in greater detail (than when soliciting the volunteers) what the study was about. I used interview guides to focus the interviews so that each participant could express her view on the aspects touched on during the interview. Two interview guides were used; one interview guide was used for the participants who study engineering (Appendix A) and a second interview guide for participants who were not studying engineering (Appendix B). The questions were open-ended to ensure that the participants had the leeway to express their feelings and experiences freely without constraint due to the formulation of the questions.

1.4.5 Data analysis and interpretation

The data from the interviews were collected and transcribed (with the use of a Transcriber software). These data were then organised and categorised into patterns such as themes that arose from the data. Data interpretation was done against the backdrop of the theories that I considered relevant to the study; some of these theories have been cited in the literature review, such as the self-efficacy theory by Bandura (1994), social cognitive theory of gender development by Bussey and Bandura (1999), I also refer to later interpretations and applications of Bandura and Bussey and Bandura's theories made since the initial forwarding of their theories and gender stereotyping.

1.5 Issues of credibility
To enhance credibility in this study the following strategies were used:

- The data collected from the in depth interviews was digitally recorded after `consent was given by participants.

- Participant language and verbatim accounts with the aid of Transcriber software were recorded as the data collection during the interviews.

- Participants were asked to review the acquired data (after it was transcribed) to ensure accurate accounts of the interviews conducted. They were also asked to assist with interpretation of the data once the themes had been drafted. (As it transpired, participants offered no additional comments or ideas.)

- In my field journal ethical considerations and self-reflection was jotted down on how I was interpreting the data. Researcher reflexivity helps researchers to acknowledge that they are part of the world constructed in their research instead of apart from it (Scott & Usher, 1996:35; Romm, 2001: 88).

- Critical reflexivity on my part was implemented in terms of self-critique about my initial personal points of view. My initial point of view was that many women are unaware of what a career in engineering entails and the benefits it holds because society portrays it to be a masculine discipline.

1.6 Ethical considerations

The following ethical concerns were considered in the study:

- Voluntary consent was obtained from all participants within this study and they were told that they had the right to withdraw from the study at any time they wanted to.

- The participants had a right to anonymity and confidentiality. The names and identities of participants were not revealed within this study.

- The participants were asked to review the collected data and my draft interpretations. This was to ensure that participants would not feel betrayed should they read the findings of the research.

- Ethical clearance was obtained for this study from the University of South Africa.

- Permission for this study was obtained from the principal of South West Gauteng College.

1.7 Limitations and delimitations of the study

Broad generalisations cannot be drawn from this study as the sample chosen was small and limited to one TVET College in Gauteng. Nevertheless, this does not preclude some "naturalistic" generalisation (Guba, 1981), where readers familiar with other contexts outside of the research study may consider the transferability (extent of applicability) of some of the results to similar contexts. Melrose (2010), expanding on this idea of “naturalistic generalisation” explains that readers can decide to what extent findings seem transferable. They can do this as long as there is sufficient richness of data for them to be able to consider the extent of similarity with other contexts with which they may be familiar. She (2010: 191) explains that:

> As readers recognise similarities in case study details and find descriptions that resonate with their own experiences, they consider whether their situations are similar enough to warrant generalisations. Naturalistic generalisation invites readers to apply ideas from the natural and in-depth depictions presented in case studies to personal contexts.

Anney (2014) adds to this by indicating the importance of the "audit trail" so that readers can establish how the data were generated and analysed in the case in question. Anney cites Bitsch (2005) in this regard: "According to Bitsch (2005: 85), the 'researcher facilitates the transferability judgment by a potential user through thick description' and purposeful sampling'" (Bitsch, as cited in Anney, 2014: 277). I hoped to facilitate this judgement on the part of readers by offering rich descriptions of participants' views and by offering an account of how I analysed the data.

1.8 Clarification of terms

Key concepts used in this study have been defined as follows:

Artisan: A worker in a skilled trade, especially one that involves making things by hand.

Self-efficacy: One's belief in one's ability to accomplish a task (Bandura, 1994).

Gender stereotype: Widely shared and accepted beliefs about characteristics that can be attributed to men and women (Gupta, Turban, Wasti & Sikdar, 2009; Eagly & Karau, 2002; Ertl, Luttenberger & Paechter, 2017).

Underrepresentation: Insufficiently represented or spoken on behalf of (Collins Online English Dictionary).

Career: An occupation undertaken for a significant period of a person's life and with opportunities for progress.

Unemployment: The situation of individuals who are employable and seeking for

but are unable to find a job.

Engineering-related fields: The field of engineering which is divided into a large number of specialty areas: mechanical engineering, civil engineering, electrical engineering, chemical engineering, nuclear engineering and structural engineering.

1.9 Organisation of the dissertation

Chapter 1 – Background and overview

This chapter deals with the introduction of the main research problem, and the aims of the study. The research approach is explained and the background of the study is described.

Chapter 2 – Literature review

This chapter deals with an overview of relevant literature to provide a sound background for the research problem. Theories relevant to the study have been expounded to strengthen and support arguments.

Chapter 3 – Methodology and data collection

In this chapter, the research design and methodology are described. The population and the sample are described and data collection procedures are explained. The population is the business, hospitality and engineering students at the College. Strategies for data gathering and analysis are outlined and a full description of compliance with ethical requirements is given.

Chapter 4 – Results and discussions

This chapter deals with the results of the study. At this point, categories, topics, and themes which emerged are discussed in detail.

Chapter 5 – Conclusions and recommendations

The final chapter summarises the investigation and conclusions drawn from the study are presented. Recommendations are put forward based on the findings of the literature and the qualitative study.

1.10 Conclusion

I chose to research the underrepresentation of women in engineering studies at TVET Colleges with a special focus on the NCV programme as I identified a gap in the literature, which is further explored in Chapter 2. In this introductory chapter, I provided a brief outline of the rationale and background of the study. I explained how my research design was appropriate to the research question and sub-questions because it allowed me to explore with participants the reasoning for choosing the courses which they did, and to consider possible obstacles experienced in making their decisions; and how they developed a sense of their capabilities. I briefly motivated my sampling of the female participants studying different courses, and also explained how I dealt with issues of credibility from a constructivist perspective, while at the same time being cognisant of ethical issues.

Change is needed and perceptions should be challenged to allow women to enter more than the quarter of Science, Technology, Engineering and Mathematics (STEM) careers that they currently hold globally (Savaria and Moteiro, 2017:92). From a South African perspective, if perceptions are challenged and change is brought about, more women could become the qualified artisans needed to support the economy and to alleviate the shortage of critical skills (Nzimamde, 2013). This was my own (ethical) starting point that informed my study.

Chapter two gives an overview of the literature dealing with the reasons for the underrepresentation of women in engineering studies at TVET colleges and explores the relevant theories associated with the lack of interest from women to pursue careers in the engineering discipline.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The review of literature on the underrepresentation of female students in engineering studies at a TVET college is organised in this chapter into three major sections. The first section gives a background to the participation of women in engineering fields worldwide; the second section explores theories that endeavour to explain why female students are not drawn to engineering studies at TVET colleges. Literature is reviewed on the implications of male and female gender roles through the lens of the self-efficacy theory, which in this study is linked to considerations around gender stereotyping (which may affect women's sense of their capabilities). The final section investigates the role of TVET colleges in South Africa with special attention placed on the NCV programmes. The social barriers that students face at these TVET colleges are also considered.

2.2 Women in engineering studies

2.2.1 Introduction

Science and engineering exert major influences upon modern society ranging from energy and transportation to health services, and therefore, play a pivotal role in the overall workforce as stated by Sonnert and Fox (2012). They further indicate that science and engineering fields are marked by notable gender disparities in terms of participation, performance, and rewards. Fox, Sonnert, and Nikiforova (2009:334) suggest that if more women enter the engineering fields, this could firstly foster the principle of social equity, expressed in the belief that scientific careers should be "open to talent" and not constrained by factors such as race and gender; secondly it would tap into the potential contribution of women to the size, creativity, and diversity of the scientific and engineering workforce. This research is focused on engineering studies and the reasons why women are not readily attracted to pursue careers in the engineering at TVET Colleges.

2.2.2 Background of female participation in engineering studies worldwide

In the United States (US), education in engineering has a gendered history. It was only until the late 1800s and 1900s that a handful of women ventured into engineering studies (Bix, 2004:28; Bauman, 2020). During World War 11 women were tasked to compensate for the shortage of the technical male workforce and were encouraged to pursue careers in the engineering discipline. This was accomplished through the 'Rosie Reverter' campaign based on the real-life experience of a female factory worker, Rosie Monroe. According to Milgram (2011:6), The 'Rosie Reverter' campaign increased the number of women in the workplace to about 20 million between 1940 and 1944 but not all were based in factories.

Since then, women have been pursuing careers in the engineering fields but a gender balance has never been reached. Globally, women hold less than a quarter of careers in STEM as opposed to 76% held by men, as indicated by Savaria and Monteiro (2017:92). They further indicate that of the women enrolled for a STEM major, only 18% of women choose engineering as opposed to 48% of men. For more women to pursue careers in the engineering field, they should be encouraged to enter this field of study, which leads us back to the main research question: Why are female students underrepresented in engineering studies at TVET Colleges in South Africa?

2.3 Gender role implications and the theories drawn upon

2.3.1 Male and female gender role implications

To gain some insight as to why female students are underrepresented in TVET Colleges, one should investigate how gender differences might affect the choice of occupation that people pursue.

As children develop cognitively, they are taught to categorise themselves as male or female according to the social cognitive theory of gender development and differentiation (Bussey and Bandura (1996). As soon as self-categorisation takes place, according to Bussey and Bandura (1999:696), "one's gender status could

determine not only dress and play, but occupations pursued and functions performed in family life." However, one should not forget that self-categorisation is a product of a society that emphasises gender differences. The theory indicates that through cognitive processing and experiences, boys and girls gain substantial knowledge about gender-appropriate behaviour. Cognitive processing in social contexts stress gender differences as far as capabilities are concerned, thus giving the impression that men and women have different capabilities.

Within the working environment, women who are in pursuit of traditionally male occupations such as engineering are evaluated in a negative light in comparison to women in traditionally female occupations. They receive less support from mentors and peers and are sometimes viewed as incompetent in these occupations; they are excluded from informal networks and activities where important information is exchanged and business transactions are conducted (Bussey & Barunda, 1999:702). McIlwee and Robinson (1992:11) state:

> Gender socialisation encourages men to develop characteristics associated with competency and achievement for a future of paid employment as they are taught the importance of mechanical, technical, and mathematical skills. Women on the other hand might envision working in the future, but their socialisation still primarily emphasises the family role.

The roles that women have been taught to play and the attitudes that they have been encouraged to assume signal a type of "second class" status, resulting in diminished self-confidence as indicated by Appelbaum, Audet, and Miller (2003: 46). They further state that a lack of self-confidence is signalled by accepting less in terms of remuneration, rewards, and praise for their leadership skills in the workplace. Within this study, I wanted to explore with the participants their sense (or not) of self-confidence. Within the interview process as guided by the interview guides (Appendix A & Appendix B) the participants were asked if they remember how they developed their sense of capabilities and whether stereotypes could have affected their sense of capabilities in a negative light.

2.3.2 Self-efficacy theory

2.3.2.1 What is the self-efficacy theory?

In an attempt to further understand the reasons why there are so few female students studying engineering at the TVET Colleges, I draw on Bandura's self-efficacy theory. Perceived self-efficacy can be termed as the belief one has in the ability to achieve something. "These efficacy beliefs influence how people think, feel, motivate themselves, and act" (Bandura, 1994:1). Perceived self-efficacy is a central mediator through which socialisation practices and past experience influence educational and career choices (Bandura, 1997). Bandura (1995:24) acknowledges that, although women make up an increasing share of the workforce, not many choose careers in scientific or technical fields or occupations that have traditionally been dominated by men. He attributes this to their lack of belief in their technical abilities as inculcated by family, education systems, mass media, and culture at large. Dissuading societal norms and practices continue to cause a lag despite the changing status of women and their increased entry into the workforce. Bandura and Bussey (1999) indicate that in recent years vast changes have been witnessed in the roles women perform, but socio-structural practices lag far behind. Bandura and Bussey (1999) elaborate on the slow change witnessed in organisational practices as beneficiaries entrench their privileges in protective organisational processes and structures. This is especially true for women in traditionally male occupations who are often viewed as incompetent in comparison to men and are excluded from informal networks and activities. However, Bandura (1995:14) indicates that as times are changing, so is the family structure as more women are joining the workforce. They have to fulfil multiple roles and women with a "strong sense of self-efficacy" manage multiple demands on their work and domestic schedules and enlist partners' help when needed (Bandura, 1995: 14).

In my research, I took into account these considerations. I set out to explore if women experience what Bandura calls a “strong sense of self-efficacy” or if they decide to choose to join the engineering course in spite of lacking a “strong sense of self-efficacy”. In this study, I focused on the self-efficacy of the women that could affect their sense of capabilities due to stereotypes in terms of engineering studies

at TVET Colleges at the NCV level. The women in the study who are enrolled for engineering studies, business studies and hospitality studies were asked about their sense of self-efficacy for engineering-related careers (cf. Appendix A and Appendix B).

2.3.2.2 Impact of self-efficacy theory

According to Betz and Hackett (1997:385), a high self-efficacy in a certain field such as academics allows an individual to consider pursuing a career option. When faced with adversity, that individual perseveres in the educational programme for the chosen field. In contrast, low self-efficacy could act as a barrier to a certain career choice for the individual as it hampers performance and persistence in the educational programme chosen for the career choice (Betz & Hackett, 1997.)

According to Bandura and Bussey (1999), occupational choices are of considerable importance because they structure a major part of a person's identity and determine their quality of life. According to them, self-efficacy beliefs "set the slate of options for serious consideration" (Bandura and Bussey 1999:292). Those with a strong sense of self-efficacy consider a wide range of occupations whilst others rapidly eliminate classes of vocations regardless of the benefits they may hold due to efficacy beliefs.

Bandura and Bussey (1999) further indicate that the pervasive stereotypic practices of various societal subsystems eventually leave a mark on women's beliefs about their perceived occupational self-efficacy. They indicate that male students have a comparable sense of self-efficacy for male and female-dominated occupations whereas female students judge themselves more efficacious for traditionally female-dominated occupations but have a weaker sense of efficacy that they could master educational requirements and job functions for male-dominated jobs, even though they do not differ in actual verbal and quantitative ability.

Bandura, Babaranell, Capara and Pastorelli (2001) found that the self-efficacy of the 272 children in their longitudinal study, who were aged between 11 and 15, is

the key determinant of their perceived occupational self-efficacy rather than their academic achievement; the analysis of gender differences reveal that perceived occupational self-efficacy predicts the traditional nature of career choices: boys tend to opt for occupations that are traditionally male-dominated and girls opted for careers that are viewed as traditionally female-dominated occupations

This begs the question as to why some women or girls have low self-efficacy for traditional male careers such as engineering. Could it be due to stereotyping? According to Bandura (1997:430), the more strongly girls adopt the stereotypical feminine gender-role identity, the more they underestimate their capability. Within the context of this investigation, the idea was to establish how women participants developed a sufficient sense of self-efficacy to enrol for the course and whether they felt they had to overcome notions of women as not capable. This was explored with the participants of the study.

Low self-efficacy for engineering-related educational programmes in women could be one of the reasons explaining why some women are not interested in pursuing a career in the engineering discipline. This is a qualitative study, unlike most of the studies done on self-efficacy which are based on examining its predictive power to predict dependent variables such as performance in academics and career choice. (Sawari, 2013; Nejad & Khani, 2004; Hacket & Betz, 1981; Webb-Williams, 2014; Fallan & Optad, 2016; Foglioti & Bussey, 2013). In section 2.3.2.3 below, I will show how each of the researchers in turn looked at gender issues concerning self-efficacy.

2.3.2.3 Does gender play a role in self-efficacy?

A theoretical controversy exists around whether or not the role of gender affects the self-efficacy of an individual. Sawari (2013) conducted a study on the general self-efficacy of students related to gender difference at four different secondary schools. He conducted quantitative research with 489 participants and collected data through a questionnaire about general self-efficacy which centred on the attitude of learners towards learning. Sawari investigated whether level of self-efficacy is the best predictor of discipline problems. It was found that both males and females have an intermediate level of general self-efficacy with a percentage

score of 57.8%, even though there are a few with low self-efficacy. However, female students have a slightly higher general self-efficacy than their male counterparts. Therefore, Sawari's study confirms that at secondary school level, girls have a higher general self-efficacy which centres on the learners' attitude towards learning but did not focus on their self-efficacy regarding individual subjects such as mathematics or science.

Nejad and Khani (2004) conducted a quantitative study at a school in India with third-grade students, studying the interaction of gender and self-efficacy on academic achievement. They found that students with high self-efficacy performed better in mathematics. They also found no significant difference between gender and self-efficacy in mathematics progress. They claim that this can be attributed to the fact that "gender difference, due to equal opportunities for both genders, has declined in recent years". This begs the question, how do they explain that there was no significant difference if a decline was experienced in recent years?

Webb-Williams (2014) suggest that children are affected by the way teachers regard them and their abilities. She conducted a study on gender differences in school children and their self-efficacy beliefs. The girls and boys that participated in the study were aged between 10 and 12. The results of the investigation showed that gender differences in self-efficacy were significant, with boys holding a lower self-efficacy than girls. She attributed these results to the classroom interaction and pedagogical approach used by the teachers involved in the study. I acknowledge the possibility that the school classrooms involved in this study could have unknowingly impacted upon the children's self-beliefs so much so that polarisation according to gender occurred. She also attributes the large difference in self-efficacy between boys and girls to their age, as other research conducted tends to focus on older individuals.

Fallan and Optad (2016) conducted a study on participants who were in the autumn semester of a second-year course in Principles of Economics at a Norwegian University of Science and Technology. Their study reveals that female students have significantly lower self-efficacy levels than their male peers; however, they claimed that this was dependent on the personality of the individual. The

researchers found that the general conclusion of lower perceived self-efficacy levels among female students only includes those having NF (Intuition, Feeling) and NT (Intuition, Thinking) temperaments or personalities. NF (Intuition, Feeling) students prefer democratically run classrooms with much interaction with other students and the professor. They are co-operative rather than competitive. NT (Intuition, Thinking) students tend to be independent learners and often self-sufficient in the classroom; they prefer discussions with the professor instead of with other learners. In this study, the different personalities will be taken into consideration and how self-efficacy affects women with different personalities.

Back in the 1980s, Hacket and Betz (1981) conducted an investigation with undergraduates at a university into the relationship of career-related self-efficacy against perceived career options. The researchers found no significant gender differences in the results across a wide range of occupational fields; however, gender differences did emerge when non-traditional and traditional occupations were compared. Results indicated that the occupational self-efficacy of men was equivalent across occupations, but the occupational self-efficacy of the women was lower for traditionally-male dominated occupations. Males perceived a physician as the most difficult occupation and females perceived an engineer as the most difficult occupation. This current study could therefore, build on, and shed light on this outcome, as the women who formed part of the sample were probed about their perceived self-efficacy for engineering-related studies at a TVET College at the NCV level.

More recently, Huang (2013) conducted a quantitative meta-analysis of 187 studies containing 247 independent studies on gender differences in academic self-efficacy. This study included participants of varied age groups as the data were based upon the analysis of the independent studies as previously mentioned. The results indicate that females display higher academic self-efficacy for language and art. Males, on the other hand, display a higher self-efficacy, for mathematics, and computer and social sciences. The outcome of this study is consistent with the study of Hacket and Betz (1981), who also found that gender differences in academic self-efficacy vary with age. For mathematics self-efficacy, significant gender differences are displayed in late adolescence. Supporting previous

research by Hyde et al. (1990) analysed 100 studies and found that girls perform better in mathematics in elementary school. However, males had higher mathematics achievement than females in high school and this difference continued in college; the difference increased as age increased.

Bandura (1997:424) explains that "it is not as if self-efficacy beliefs remain mysteriously inert in earlier developmental periods but that it arises abruptly as determinants of cognitive skill development and achievement in college." Therefore, at the college level, self-efficacy becomes a determinant in the development of cognitive skills; if women have poor self-efficacy at this level due to gender stereotypes in their socialisation, it hinders their cognitive skill development. In the study, I, therefore, chose to explore with the participants how they remember their development of self-efficacy and whether at a younger age they felt they had capabilities to pursue a career in the engineering field.

Fogliati and Bussey (2013) conducted a study with 80 participants (54 female) on the effects of stereotypes on woman's intentions to improve their mathematical ability at a university in Australia. The ages of these participants ranged between 18 and 48 years. The authors examined whether the female-mathematics stereotype not only impairs women's performance but if it also affects their self-esteem with negative feedback and reduces their motivation to improve their mathematical skills. The findings suggest that indeed the effect of stereotype threat on women's mathematical performance is potentially compounded by its capacity to reduce motivation to improve their mathematical abilities and skills.

Bandura and Bussey (2004) indicate that infants and toddlers are shaped and told what is appropriate for their gender and not their self-efficacy. This is done by structuring an environment for them and reacting differentially for gender-linked behaviour. However, the more self-knowledge and self-appraisal skills children acquire, the beliefs they form about their capabilities exert influence on their development. Because of their limited cognitive skills and the fact that young children have "sketchy" knowledge of their capabilities and difficulty in distinguishing between minor and important indicators of capabilities, they are unable to benchmark their abilities against those of their peers. However, as

individuals grow older, as indicated by Bandura and Bussey (2004), belief in one's efficacy shapes the course of development by the activities and social environments individuals select. Efficacy beliefs influence the occupations that individuals seriously consider, the interest they have in them, and their resilience in pursuit of careers that are considered challenging.

Most studies dealing with self-efficacy are quantitative as they attempt to extend, apply or modify Bandura's concept which he defined using quantitative ways of measurement and correlation and prediction between self-efficacy and performance as the dependent variable. From the literature reviewed, it is clear that the quantitative literature is inconclusive and I thus decided to explore this topic qualitatively with participants in the South African context. There is no easy path to 'applying' Bandura's argument in the context of this study as this study is qualitative in nature.

2.3.3 Gender Stereotyping

2.3.3.1 What is gender stereotyping?

As indicated in the Section above, controversy in the literature remains as to the issue of whether and how gender stereotyping might affect people's sense of self-efficacy. In order to contribute to the body of knowledge in the literature, this study tried to understand this issue further with reference to the engineering and other students at the chosen TVET College. In this study, the participants themselves were asked to reflect upon how they developed a sense of self-efficacy; they were asked if they had to overcome visions of women (to which they may have been exposed) as not being capable as men. They were asked if they think that stereotypical conceptions are still prevalent in the wider society and their relations with family and others in their immediate social circles. They were asked if they were perhaps influenced by female role models. Therefore, the women were further asked if they feel that stereotypical visions affected their initial self-efficacy and, if so, what enabled them to overcome them. Their points of view concerning the underrepresentation of females in engineering studies at TVET Colleges were thus explored as part of my contribution to the literature. I believe that this is a credible way of casting further light on the debates in the literature.

Gender stereotypes can be defined as widely shared and acceptable beliefs about characteristics that can be attributed to men and women (Gupta et al., 2009; Eagly & Karau, 2002). Gender stereotype studies indicate that women are perceived to be caring and interdependent, where men are perceived to be more ambitious and self-reliant (Rudman & Phelan, 2008). Later studies suggest that these are not the only perceptions operative and that currently there may be other visions of women and men and the role models portrayed through them. Hentshel, Heilman and Peus (2019: 2) indicate in this regard that “recent research findings are inconsistent, some suggesting that there has been a change in traditional gender stereotypes … and others suggesting there has not (e.g., Haines et al., 2016)”. This is what was further explored in the study, as indicated above.

According to Smeding (2012:617), stereotypes can undermine the self-perception of women and girls concerning their abilities, performance, and even interest in pursuing a career that does not fall in the confines of the stereotype (e.g., so-called masculine disciplines). Given the literature on stereotyping, I explored if the women who form part of the sample felt that stereotypes of women still function in South African society which may have influenced them and how, if at all, they found ways to overcome these stereotypical images of women. In other words, I was exploring with them the issue of stereotyping and how this might underline self-perceptions.

2.3.3.2 Implications of gender stereotyping

Smeding (2012) conducted a study in the US by investigating implicit STEM stereotypes amongst engineering male and female students as well as male and female students in the humanities. The results indicated that engineering female students held weaker gender-reasoning stereotypes than female humanities students, male engineering students, and male humanities students. It seems that these female engineering students could hold in their consciousness strong stereotypes of themselves as having different reasoning powers than men but still believe they could be engineers. This gives the impression that if gender stereotypes held by individuals are "dismantled" in the wider society, more women could be attracted to pursue engineering studies. In this study, my research

contributes to the literature by exploring with participants their views on how such gender-related stereotypes may be “dismantled” or at least their effect on women mitigated.

The United Nations, Educational, Scientific and Cultural Organisation (UNESCO) (2015) acknowledges the threat of negative stereotypes against women and the importance of developing a “growth mind-set” to allow talents and abilities to develop over time. In this study, I examine whether the participants have cultivated a growth mind-set and how they did this in the face of stereotypes to which they may have been exposed? The UNESCO (2015) report further reveals that the wider issue of negative stereotyping leaves room for the gender dimension of mathematics and science at secondary education level which functions negatively against girls. If this negative stereotype against girls is not addressed at the secondary education level and girls believe that only males can do subjects like mathematics and science, it could affect later studies or careers chosen by girls as they get older as mathematics and science are the subjects needed to pursue STEM careers in future.

2.3.3.3 Gender stereotyping at the school level

The UNESCO (2015) report reveals that gender differences in STEM fields are rooted in student performance at the secondary education level among students as young as 15 years old. This illustrates the threat of gender stereotyping upon the lives of young women. Dar-Nimrod and Hein (2006) define a stereotype threat as a phenomenon where self-relevant stereotypes are activated, showing people adopting stereotype consistent behaviour and thereby perpetuating stereotypes. An example of this is cited by Nosek, Smyth, Sriram, Lindner, Devos, Ayala, and Kesebir (2009) indicating that world-wide, Grade 8 boys show significantly greater achievement than girls in science; observations of such a difference have reinforced the view that boys are “naturally” better equipped to excel in mathematics and science.

Teaching and learning materials, especially textbooks, continue to perpetuate stereotypes in the manner in which male and female roles are portrayed in STEM-

related subjects such as mathematics and science. As indicated by UNESCO (2015) the content of the 2013 curriculum for mathematics and science is considered gender-sensitive in Indonesia, however, a Grade 7 textbook illustrates students learning science and all of them are males. A Grade 9 Cambodian science textbook illustrated the central nervous system and indicated the different functions of the brain where males are depicted thinking and exercising contrasted against females who smell flowers. Various other studies support the notion that at the schooling level, pervasive stereotypes play a role in defining the ways in which boys and girls are either encouraged or not to engage positively in mathematics and science education (e.g., Baram-Tsabari & Yarden, 2008; 2011; Fredricks, Hofkens, Wang, Mortenson, and Scott, 2018; Mbabaali, 2018; Musimenta, Adyanga & Sekiwu, 2020; Sichangi, 2017). The argument is that the images that are portrayed of boys' and girls' propensities might not always depict an explicit stereotype, but stereotypes do not have to be endorsed explicitly to influence individual behaviour (Steele, 1997; 2009; Ertl, Luttenberger, & Paechter, 2017). It is therefore important to be vigilant of the type of learning material learners are exposed to and how the underlying stereotypes could influence their behaviour.

2.3.3.4 How to combat stereotypes

Nozek et al. (2009) report on a study conducted on Grade 8 mathematics and science students. They collected data across 34 nations who participated in the Trends International Mathematics and Science Study in 2003. They found that "a national indicator of implicit gender-science stereotyping was related to nations' sex differences in science and math achievement." They further argue that if implicit gender stereotypes and sex gaps in scientific engagement are mutually reinforcing, then educational campaigns calling for greater female participation and performance in mathematics and science must first overcome pervasive implicit stereotypes embodied in the minds of individuals. This is consistent with Steele (1997), who indicates how stereotypes can shape intellectual identity and performance, and hence need to be overturned. Ertl, Luttenberger and Paechter (2017) concur on the reciprocal effects between academic self-concept and learning motivation.

Studies show that stereotypes are activated automatically. However, Deutsch (2007:116) states that automatic access to stereotypes can be reduced through exposure to counter stereotype images and thoughts and through intentional attempts to avoid prejudice. Resistance offers another method of dismantling gender stereotypes: when an individual challenges boundaries through resistance, it could encourage the collective to transform institutions through feminist consciousness that has been awakened.

This current investigation aimed to determine if “the collective” could be encouraged to transform the TVET College in Gauteng in terms of the female representation in engineering studies. If students are provided with an opportunity to reflect on their behaviour and beliefs when participating in the study or if they draw on the findings of the study and share their accounts with others, feminist consciousness could be further awakened in the college.

2.4 Role of TVET Colleges in South Africa

2.4.1 What are TVET Colleges?

TVET Colleges have been viewed as an important mechanism for offsetting some shortcomings of the education system during the apartheid era as they provide an alternative learning pathway (Gerwer, 2009:2). TVET Colleges also aims to increase the employability of youth in a challenging labour market. Nzimande (2013) states that South Africa needs to develop qualified artisans to support the economy. Nzimande further indicates that the Department of Higher Education and Training has invested billions in the development of TVET Colleges to make them the institution of choice to develop these skills whilst challenging the idea that trades and other vocational programmes are for those who cannot get into universities (Nzimande, as cited in Akojee, Gonon, Hauschildt & Hofmann, 2013:1-2).

Concern has been expressed (Powell & McGrath, 2014) that the wave of optimism and interest in TVET colleges around the world could be based on this two assumptions. The first assumption is that training leads to productivity followed by economic growth, and the second assumption is that skills lead to jobs and eventually to employment to alleviate poverty. These assumptions fuel the idea of "productivity" for the workforce in the TVET sector leaving little room to prepare learners for family life and challenges that they might experience in the future apart from the industries they venture into. The participants of the study were asked if they too feel that the TVET sector concentrates mostly on ‘productivity’ and places less focus on preparing learners for family life and future challenges they might encounter.

Research indicates (Jackson & Laanan, 2011) that compared to men, women scientists and engineers are more likely to have attended a community college before commencing studies at universities in the US which is why these TVET College institutions have been recognised as key players to increase participation of women in STEM areas in that country. This is a practice that could benefit us as South Africans.

2.4.2 NCV Programme

The engineering profession is technical in nature and the first South African technical colleges were developed and administered under the 1923 Higher Education Act to incorporate theoretical and industrial training simultaneously (Zwane, Surujlal & Dhurup, 2014:990). This type of training has subsequently evolved into a mixture of theoretical and 'on the job' training. Before 2007 TVET Colleges mostly provided theoretical training from N1-N6 in various engineering courses and 18 months of experiential training in the industry allowed learners to qualify for their diplomas (DOE, 2000/3). In 2007 the NCV programme was introduced as a 3-year programme, namely Level 2, Level 3, and Level 4 which has a practical component for all the vocational subjects. This programme aimed to grant learners exposure to the practical aspect of their occupation before they enter the workplace (DOE, 2006). The NCV certificate opens doors for further training at the TVET College N4-N6, or students gain access to universities with the required technical background as an advantage (DOE, 2007). This study sought in this context to explore the underrepresentation of women in engineering studies at TVET Colleges, specifically at the NCV level.

2.4.3 Social barriers for students redirecting them to TVET Colleges

Powell and McGrath (2014) conducted a study wherein South African students explained the reasons why TVET Colleges were their learning institution of choice. Some of the following reasons were listed by the students in their study:

- TVET College offers a better learning pathway or programme.

  Some learners explained that the college has a programme that offers a mixture of theory and practice. Some learners left school after completing Grade 9 to pursue the NCV programmes of choice and the NATED programmes afterward in an attempt to pursue their desired careers.

- TVET College serves as a space for rehabilitation.

  Some students discussed social pressures they experienced when mixing with the wrong peers in high school. Some of these choices lead to drug and alcohol abuse. In these cases, the college served as a platform to meet different types of people and exposure to different lifestyles.

- TVET College are a route to artisanal work.

Some students want to complete their 'technical matric' to do further studies and become qualified artisans. This group usually has a role model in the family whom they want to emulate. Other learners want to study further and become qualified engineers.

- TVET College is a route to career mobility.

Some students came from industries where they have been working in positions without earning satisfactory salaries or enjoying employment benefits due to the lack of qualifications. TVET Colleges serve as a route to obtain the desired qualifications to obtain the desired positions in the workplace.

- TVET College is a vehicle for meeting familial and community responsibilities.

Some students returned to college after dropping out at a young age and others returned to college after fulfilling familial responsibilities. College offers a second opportunity to pursue their desired careers to better equip them for familial and community responsibilities.

- College as a bounded choice.

Some students completed Grade 12 but their results did not allow them to enter into institutions of higher learning. In contrast, other learners had the marks to qualify for entrance into such institutions but financial constraints persuaded them to choose TVET Colleges as the learning institutions to complete their studies.

To understand some of the reasons for the underrepresentation of women in engineering studies at the TVET Colleges, the participants chosen for this investigation were encouraged to elaborate on social barriers that they encountered that could contribute to the underrepresentation of women in the engineering discipline. They could elaborate on the platform that TVET Colleges provide or should provide to encourage women in these disciplines.

2.5 Conclusion

From the literature review, it is evident that science and engineering exert major influences upon modern society and yet these fields are marked by notable gender disparities and inequalities The literature indicates the male and female role implications are complex in nature but offers some understanding as to the different roles men and women are supposed to fulfil according to society. It reveals that gender stereotypes can be formed due to gender role socialisation. Therefore, engineering is sometimes classed as a masculine discipline and this may encourage the perception that boys are better equipped to excel in mathematics and science, due to the stereotypes formed. These stereotypes could have serious implications for the confidence of girls and young women as well as their sense of efficacy. However, literature also points to some shifts in the understanding of the different roles that women are 'supposed' to perform and that gender stereotypes can be shifted. This study set out to explore if and how stereotypes affect the confidence of our young women attending TVET Colleges in South Africa and how they could overcome them or at least mitigate their influence on them.

The literature reviewed indicates that compared to men, women scientists, and engineers in the US are more likely to have attended a community college before attending universities. TVET Colleges have been targeted as key players to increase the participation of women in the STEM area in the US. From a South African perspective, TVET Colleges have been viewed as an important mechanism to compensate for certain shortcomings of the education system during the apartheid era and to increase the employability of youth in a challenging labour market. TVET Colleges provide an avenue to develop qualified artisans to support the country's economy. This investigation was aimed at ways to attract more women to engineering on an NCV level as research at this level is scant and to explore the underrepresentation of women in engineering studies at a TVET College in Gauteng.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction
Chapter 2 provided a theoretical background for some of the reasons for the underrepresentation of female engineering students at a TVET college in Gauteng. This chapter presents the methodology used to obtain the data used in this study, explaining the research paradigm and design chosen.

3.2 Research paradigm
The research paradigm chosen for this study is the constructivist paradigm. The constructivist design tends to focus on the feelings, beliefs, and perspectives that the participants express as they engage with the researcher and are prompted to explore and deepen their insights or perspectives in this process (McMillan & Schumacher, 2010:347; Lincoln & Guba, 2013: 70-71). The investigation aimed to explore with participants the social phenomenon concerning the underrepresentation of female engineering students at TVET Colleges. In an attempt to achieve this, I examined obstacles such as gender stereotypes that the participants had to overcome and how they felt that they had changed their view of their capabilities despite current gender stereotypes. The idea was to reflect together with them on this process and therefore, make statements about why many females do not readily choose to study engineering-related courses. This paradigm was also chosen because as a researcher my perspective and judgment are also considered in the interpretation of the data collected, as will become more evident in Chapters 4 and 5.

3.3 Research approach
The research approach is a qualitative research approach and the specific qualitative approach adopted is one that is based on the constructivist epistemology. Constructivist epistemology, according to Guba and Lincoln (1994), Lincoln and Guba (2013) and Romm (2001: 117-118), implies that as a researcher one cannot gain access to phenomena without knowers and the known interacting and communicating; data is then *generated* through this interaction and communication. Knowing is a social relationship where “data” emerges as people interact with one another. This study entails an investigation with selected

participants into a social phenomenon (possible reasons for women not entering engineering study fields), which is why a qualitative research approach is appropriate for this study.

3.4 Research design

The research design of choice is based on a phenomenological approach. A phenomenological study is one that aims to describe/explore the meaning of a lived experience as people reflect together on its meaning, as part of their making sense of a particular experience or situation (McMillan & Schumacher, 2010:24). The basic assumption of phenomenology is that there are multiple ways of interpreting the same experience for each participant constituting the reality (McMillan & Schumacher, 2010:346).

This design is appropriate for this study as it aims to account for the limited number of female engineering students at a TVET College and to gain some understanding of why female engineering students chose this career path. It also aims to clarify why female engineering students have chosen the NCV programme that contains the practical aspect of the training. This design is also appropriate to account for the experiences of women at the TVET College who chose not to pursue careers in the engineering field, and their reasons for their choice doing so. A greater understanding of these reasons could implore guidelines to encourage more women into the engineering studies at TVET Colleges.

During the interviews in this study, the participants were asked to reflect on some depth upon their self-efficacy and their capabilities (refer to Appendix A and Appendix B). According to Bandura (1994:2-3), there are four methods of creating a strong sense of efficacy, namely:

- “Mastery, by building on previous success, people feel confident in their abilities but failure could undermine the efficacy if it has not been firmly established yet.” - For this investigation, I am exploring how women feel in social contexts.
- “Vicarious experiences that are provided by social models and the experiences of those around us. That is if someone can relate to and succeed in something, surely we can too."

- “Social persuasion, people can be persuaded verbally that they have the capabilities to accomplish something.” - The converse of this statement is also true. Gender stereotypes can persuade women that they do not have the capabilities or that even if they have, they will not be able to realise them in a world dominated by stereotypes.
- “Physiological and emotional states in judging their capabilities.” - However, gender socialisation might not acknowledge or encourage the capabilities of women which in turn could challenge their judgment of their capabilities.

According to Romm (2018:26), researchers can do "active research", where their research could become the vehicle for change by helping participants and wider audiences to reflect on social issues (such as issues related to gender stereotyping); however, this should be no reason for researchers to impose their own bias or predilections upon the outcomes of research conducted This is why the credibility measures that I mentioned briefly in Section 6 (1.6) of Chapter 1 and discuss in more detail in Section 9 below were employed in this study (3.9).

3.5 Sampling

As advised by authors such as Lodico, Spaulding & Voegtle (2006:140 and ; Onwuegbuzie & Leech (2007: 106) I chose the sample based on the characteristics and knowledge that I considered the participants would have concerning the questions relating to the investigation in their natural context (Lodico, Spaulding & Voegtle, 2006:140; Onwuegbuzie & Leech, 2007: 106). This study took place at a TVET College in Gauteng. I am currently employed at SWGC and the study took place at this particular college. Female students at three different campuses were sampled for the investigation. Female students studying engineering NCV based at the engineering campus were contrasted with female students studying hospitality (NCV) at the campus offering hospitality courses. Female students studying business studies (NCV) at the campus offering business courses were also compared to the female students studying engineering. This was a sample of convenience.

Since level 2 is the entry-level for the NCV course, the target sample consisted of level 2 female participants.

At the engineering campus, six different trades are offered, namely plumbing, carpentry, masonry, automotive, fitting, and welding. Volunteers who were keen to participate in the study formed part of the study. One female participant was selected from the four trades (automotive, welding, carpentry and masonry) and two female participants were selected from the plumbing trade (N=6). To solicit the sample, I went to each of the various classes at the campus, addressed them about the study in general and asked them if anyone would be interested to participate, mentioning that I needed one person from each of the six trades. In the end six participants volunteered; however, they represented five trades instead of the desired six trades.

At the hospitality campus, three female volunteers enrolled for the level 2 hospitality course formed part of the sample for the study (N=3). Finally, at the business campus, three female volunteers enrolled for the level 2 business course formed part of the sample (N=3). (At the business and hospitality campuses, I addressed one class at each campus – one class with business students and one

class with hospitality students. I explained the study and then asked if anyone was willing to participate and mentioned the number of participants needed, that is, three business participants and three hospitality participants.

3.6 Participants

SWGC is situated in the south-western area of Johannesburg. This College is made up of six different campuses that offer various courses at each campus respectively. Three campuses were chosen as applicable to this investigation: Molapo Campus, the engineering campus; Dobsonville Campus that offers business studies; and Roodepoort Campus that offers hospitality studies. Table 3.1 indicates the number of female students chosen from each campus in Level 02 for the three selected study fields.

Table 3.1: Participants and their fields of study

Participants (NCV)	**Engineering Studies**	**Business Studies**	**Hospitality Studies**
Number of participants	06	03	03

The participants were chosen via a process of seeking volunteers (based on certain criteria) from various campuses. At each campus, the intentions of the study were explained to the learners, and any volunteers were asked to participate in the study. This study is therefore limited to the volunteers who were willing to participate in this study. The criteria for selection of volunteers were: i) female learners ii) registered for level 02 engineering studies at Molapo Campus (6); level 02 business studies at Dobsonville Campus (3), or level 02 hospitality studies at Roodepoort Campus (3). The female participants who formed part of the study were 11 black and one ‘coloured’ South African women, all of whom are 18 or older. The highest grades passed for these participants ranges between Grade 10 and Grade 12. It is important to note that not all these women had Mathematics or Science in Grade 12 as these subjects are key determinants for entry into engineering courses.

3.7 Instruments and data collection techniques

The method of data collection was in-depth interviews with the chosen sample. One on one interviews were conducted with each one of the chosen sample participants. An interview guide was employed as a guide for me to touch on issues to be raised during the interview, as also relevant to the topic of my investigation. Two interview guides were used: one interview guide for the participants who study engineering, wherein these participants were asked why they chose engineering as career (Appendix A) and a second interview guide for participants who do not study engineering, wherein these participants were asked if they did at some point consider a career in engineering and what obstacles they might have encountered to not materialise this desire if it existed (Appendix B). These questions were open-ended to encourage participants in the sample to express their feelings and experiences and not feel constrained by the way the questions were set.

Each interview with the participants ranged between 45 – 60 minutes at the three different campuses of the college, namely Dobsonville campus, Molapo campus and Roodepoort campus. These interviews were conducted after hours and were conducted in English with the aid of a digital recorder. I have given the participants pseudonyms, refer to chapter 4. During the interview I tried to put the participants at ease to build rapport and assured them that they did not have to answer any question that made them feel uncomfortable (as I am lecturer and thus in a high status position at the same college). However, the fact that some of the learners do know who I am at that very college has also assisted in building rapport as they have seen me around on campus before (even though I do not teach any of them). Extended time in the field by the researcher allows for increased insight into the context of the study and encourages trust of the respondents (Anney, 2014).

3.8 Data analysis and interpretation

After the data from the interviews were collected, the recordings were transcribed and then organised and categorised into patterns such as themes (as laid out in Chapter 4). Software (Transcriber) exists to accurately transcribe the interview into verbatim accounts of the interview and this helped me to organise my data as I could see the totality of words used by each participant concerning other participants. Transcriber can be used for transcription and the annotation of speech

signals useful for linguistic research. This software supports multiple hierarchical layers of segmentation such as entity annotation, speaker lists, topic lists and overlapping speakers. Unicode and other character encodings are supported by Transcriber software, two views of sound pressure may be viewed at the same time at different resolutions. Transcriber is written in Tcl/Tk with. Snack audio library and is therefore available on most major platforms (Wikipedia, 2017).

Coding was done against the backdrop of the theoretical framework mentioned above. The coding was approached with the research questions in mind, highlighting rich and significant quotes or passages in response to these questions (Braun & Clarke, 2006)

The data interpretation was done against the backdrop of the theories that are relevant to the study (e.g., Bandura, 1994; Bussey & Bandura, 1999; and later interpretations and applications of Bandura and Bussey and Bandura's arguments, since the initial forwarding of their theory). Some of the theories cited in the literature review are:

- Bandura's (1994) self–efficacy theory, which explains the belief one, has in oneself to achieve something. Perceived self-efficacy can be termed as the belief one has in the ability to achieve something.

- The social cognitive theory of gender development and differentiation can have an impact on the occupations pursued by individuals as explored by Bussey and Bandura (1999). The theory indicates that through cognitive processing and experiences boys and girls gain substantial knowledge about “gender-appropriate behaviour".

- Gender stereotyping that defines the widely shared and accepted beliefs concerning men and women. (Gupta et al., 2009; Eagly & Karau, 2002) To try and understand why women are underrepresented in engineering studies at TVET Colleges, gender stereotyping is reflected upon and its impact on the self-efficacy held by the women who form part of the chosen sample.

3.9 Issues of credibility

To enhance credibility in this study, the following strategies were used:

- The data collected using the in-depth interview were digitally recorded after consent was given by participants;
- Participant language and verbatim accounts during the interviews were recorded as the data collection;
- Participants were asked to review the acquired data (after it was transcribed) to ensure accurate accounts of the interviews conducted. They were also asked to assist with the interpretation of the data once the themes were drafted.

Hence “member checking” (Anney, 2014: 26; Lincoln & Guba, 2013: 71) was undertaken at the stage of checking the transcripts and at the stage of asking participants if they wished to comment on themes. (At neither stage did the participants offer alternatives to the accounts presented to them.)

Researcher reflexivity helps researchers to acknowledge that they are part of the world constructed in their research instead of apart from it (Scott & Usher, 1996:35; Romm, 2001: 88). To enhance interpersonal subjectivity and reflexivity, as I am currently employed at the college under investigation, the following strategies were used:

- Ethical considerations were recorded in my field journal as well as self-reflection on how I was interpreting the data comprised by the participants’ expressions and the literature
- Critical reflexivity was implemented in terms of self-critique about personal points of view.
- I intended that Intersubjective checking of my interpretations with participants would take place so that I could develop my interpretations in dialogue with them. As it happened, none of the participants offered alterations to my draft interpretations; but at least they were allowed to do so.

3.10 Ethical considerations

The following ethical concerns were considered in the study:

- The participants who partook in the study as part of the chosen sample gave voluntary consent for participation. They signed consent forms as they are above the age of 18. They were informed in this letter that they had the right to withdraw from the study at any time and should not feel compelled to continue if they do not want to.
- The participants had a right to anonymity and confidentiality. No names or descriptive information was reported in the study for public use to protect the identity of the participants.
- As mentioned earlier, the purpose of the study was clearly explained to the participants so that they could make an informed decision about participation. Further to this, they were asked to review the collected data and my initial interpretations. From an ethical point of view, this was to ensure that participants do not feel betrayed when they read the findings in the research.
- Ethical clearance was requested and obtained by the University of South Africa from the College of Education Ethics Review Committee for this research. This clearance certificate is valid from 2019/08/14 to 2022/08/14.
- Permission was requested and obtained from the principal of South West Gauteng College to conduct research at Molapo campus, Dobsonville campus, and Roodepoort campus upon communication with the relevant campus managers to ensure that interviews were conducted with participants after hours.

3.11 Limitations and delimitations of the study

A possible limitation of this qualitative study is that broad generalisations cannot be drawn. As in all qualitative research, the intention from the start was depth and not breadth, As is typical of qualitative research, a small purposeful sample was chosen from a single college in Gauteng and the study has been demarcated to a specific college in Gauteng. Nevertheless, readers who have some knowledge or experience of TVET colleges in Gauteng and also in other provinces may find that the results of the study have resonance with some of the contexts with which they are familiar. So in this sense, the study could be called transferrable to these

contexts in terms of "naturalistic generalisation" (Anney, 2014: 272; Guba, 1981: 77).

3.12 Conclusion

This chapter provided an overview of the methodology followed to collect the data. It explained the sample size, how the data was collected and what was done to analyse the data. Issues of credibility and ethics were also discussed to explain how responsible research was conducted through the qualitative methods of research.

CHAPTER 4
RESULTS AND ANALYSIS

4.1 Introduction

The main aim of the investigation was to explore the underrepresentation of female learners in the engineering fields at a TVET College in Gauteng. The previous chapter explained the methodology followed for a qualitative study in an attempt to explore some of the reasons for the underrepresentation of female learners in the engineering disciplines. In this chapter, the data collected from the participants were analysed and six main themes emerged in response to the question posed.

4.2 Data analysis and interpretation

Qualitative data analysis has sometimes been defined as an inductive process of organising data into categories and identifying patterns into relationships among the categories (McMillan and Schumacher, 2010). However, some researchers argue that it is not just inductive as researchers are also using some theoretically derived categories and conceptions to make sense of the data. Pope, Van Royen and Baker (2002) argue that the logical process can be both inductive (that is, attained readily from the data) and deductive (that is, with a "theoretical framework or background”). According to Saldana (2016: 6), codes are researcher generated and do not just emerge inductively. How researchers perceive and interpret what is happening in the data depends on what types of the filter cover the research lens and from which angle the phenomena are viewed, as also noted by Gläser-Zikuda, Hagenauer and Stephan (2020, paragraph 11). In this study, my theoretical lens influenced how I decided to code, categorise, and create themes. The data interpretation was done against the backdrop of the theories relevant to the study; some of these theories have been discussed in the literature review, such as Bandura (1994) and Bussey and Bandura (1999). I also drew upon later interpretations and applications of Bandura and Bussey and Bandura's arguments (2004), since the initial forwarding of their theory. Bussey (1999) focuses specifically on gender issues and with co-authors, she develops additional

arguments. Some of the theories cited in the literature review (see Chapter 2, in particular Section 2.3.2.2 and 2.3.2.3)

Analysis in this study was based on data that were collected through one-on-one interviews conducted. This evidence is in the form of verbatim accounts of the semi-structured interviews conducted with participants. The data from the interviews were collected and organised and categorised into patterns such as themes that I interpreted as arising from the data. Software used in this study was an application known as "Transcriber". The software programme was used to assist with the transcription process to ensure that verbatim accounts of the conducted interviews are recorded.

Upon completion of the transcription process, the data were coded to form categories that formed the basis of the themes. This coding process was done manually. Coding of the data was done against the backdrop of the theoretical framework mentioned earlier and approached with specific questions (the research questions) in mind that I wished to code around; I coded to identify particular features of the data set. I systematically worked through the entire data set and identified interesting aspects in data items that formed the basis items which in turn formed the basis of repeated themes across the set of data (Braun & Clarke, 2006). During the coding process, the aim was to pick up on similarities and contrasts from the responses given to questions posed to the participants of this study. By highlighting rich or significant participant quotes or passages that struck me, I formed the basis of the coding process. Categories as clusters of similar codes in turn led to the themes that were formed in the analysis of the research. Solo coding was the process that I made use of as I was the only person who formed the codes. Once the codes and themes were formed, I drafted a preliminary report of the findings. This report I distributed to the participants with whom I conducted the interviews via e-mail. In the e-mail, I asked if they agreed with the themes that I located, and if they felt these concepts helped to understand the issues that they had raised during their interview with me, based on the write-up of the preliminary report of the findings of the study. Unfortunately, none of the interviewers added or modified anything in the report and were unable to offer new ideas/themes. However, from an ethical point of view, they were given this opportunity.

4.3 Results

The results of the qualitative study start with a brief overview of the profile of the participants at Molapo Campus, Dobsonville Campus, and Roodepoort Campus of South West Gauteng College to provide context to their comments in the interviews.

The NCV engineering department at Molapo Campus is subdivided into two parts: the Civil Engineering department and the Engineering and Related Design (ERD) department. Under the Civil Engineering department, the plumbing trade, carpentry trade, and masonry trade are offered. Under the ERD engineering department, the automotive trade, the fitting and turning trade, and finally the welding trade is offered. Within this investigation an attempt was made to find a representative from each trade, however, the sample was chosen as per volunteers from the different trades. Unfortunately, it was not possible to get a representative from each trade. However, five of the six trades were represented for this study: two participants study plumbing, one studies carpentry, one studies masonry, one studies welding, and the last participant studies automotive studies.

Engineering participant 01 (Eng.01) is a learner who does civil engineering and her trade is plumbing. While she was growing up, she always heard about engineering. At a later stage an uncle informed her about the engineering course offered at SWGC, Molapo campus, and she decided to enrol and see how things went.

Engineering participant 02 (Eng. 02) is enrolled in the welding programme. The welding programme falls under the ERD discipline of the NCV programme; her highest grade past is Grade 11. She indicated that while growing up, she thought she was going to be a nurse or a teacher, but as she grew older, she was exposed to engineering, something that you could do with your hands. She left the normal mainstream school and enrolled at a technical school. The most common stereotype she is confronted with as she pursues studies in welding is that people say she might lose a fingernail whilst pursuing this profession.

Engineering participant 03 (Eng. 03) is a civil engineering student who says she was inspired by the builders who were building the “Jozi towers” and the “Mandela bridge”. They motivated her to do civil engineering. She is 19 years old and the highest grade passed is Grade 12. She says that when she was in Grade 11, she was doing physics and went to Braamfontein on a school trip. She saw two girls studying civil engineering and this intrigued her. She asked them why they chose this career path and they said it was their passion for civil engineering that led them along this path. She is currently doing Masonry.

Engineering participant 04 (Eng.04) is 21 years old and the highest grade passed was Grade 11. She currently studies automotive engineering. She says that when she was younger, she enjoyed playing with boys' toys like cars. The day she was involved in a car accident, she realised she wanted to do automotive studies and design a car one day. That is when she realised that mechanical engineering is her interest.

Engineering participant 05 (Eng. 05) is a 20-year-old civil engineering student who does carpentry. Her highest grade passed was Grade 12. She always dreamed of being a nurse one day, but things did not work out as she had hoped and engineering was her second choice. She says she feels like she can master this course but some subjects are challenging. She indicates the reason why she chose to study carpentry is that she would like women empowered in the construction sector.

Engineering participant 06 (Eng.06) is an 18-year-old plumbing student. The highest grade that she passed was Grade 11. She says that she feels that she would not have reached the potential she wants to reach had she chosen a different career path. She is passionate about improving sanitation in our country.

The participants of the Business Studies are sampled from the Dobsonville campus of South West Gauteng College, as previously stated; these are all NCV level, 02

female participants. At this campus, three different courses fall under the Business Studies offered at this campus, namely: Office Practice, Marketing, and Finance.

Business Studies participant 01 (B.S 01) is currently 20 years old and is studying finance under business studies. The highest grade passed was Grade 11. She says she liked engineering when she was at school and would have loved to do chemical engineering, but her marks did not allow her. She chose to do finance because she feels that she is better at accounting than at science. When she was at school, she was part of a school programme called F1 project, where she and other team members had to design a car on a computer and then this had to be translated into a practical car. She found it very interesting and enjoyed the project.

Business Studies participant 02 (B.S 02) is 22 years old and the highest grade passed was Grade 11. She is enrolled in the office practice programme under Business Studies. She indicates that she has always been a confident person especially academically until she reached Grades 11 and 12 where she did not perform as well as she had hoped academically. Her confidence took a knock but she says her confidence has returned now.

Business Studies participant 3 (B.S 03) is 20 years old at present and her highest grade passed was Grade 12. She is doing Finance and her dream was to study Biokinetics at the University of Johannesburg, but could not qualify to do this course. She decided to do Business Studies as she feels she would much rather do accounting than science.

The participants who currently study Hospitality were sampled from the Roodepoort campus of SWGC. There were three female students doing level 02 in hospitality (NCV).

Hospitality participant 01 (Hosp. 01) is a 22-year-old learner enrolled for hospitality at the Roodepoort campus. Her dream was to be a nurse one day but things did not work out the way she had hoped. She says that she chose hospitality because she wants to be a military chef one day. “You can't be a military chef”, she says, “without knowing about guns or how to dress a wound”.

Hospitality participant 02 (Hosp. 02) is a woman who is married and has a family. She says she chose to study hospitality because she wants to cook healthy food for herself and her family as she is diabetic. She also wants to teach her community about healthy food.

Hospitality participant 03 (Hosp. 03) is a 27-year-old learner currently studying hospitality. She was previously enrolled for automotive studies (ERD) at Molapo campus but decided she would much rather pursue a career in Hospitality. She completed all her NCV L2 modules, including several L3 modules and L4 modules for the engineering course she pursued before changing her course to Hospitality which she is currently studying.

From the data analysis of the interviews conducted with the participants, the following six themes emerged as seen in Table 4.1.

Table 4.1: *Themes that emerged from the data collected and analysed.*

Themes
1. Desire for equality in the engineering career path
2. Stereotypes
3. Self-efficacy
4. Lack of information/education
5. Influence of Mathematics and Science marks on learners of TVET College
6. NCV as practical course

4.3.1 Desire for equality in the engineering career path

From the data gathered it appears that participants who are currently studying engineering, express a desire to be treated as equals with their male counterparts in the classroom and in society. From the data gathered through the interviews conducted with the participants, it became evident that four of the six students

studying engineering expressed a desire for equality in the engineering career path - a desire that women and men are given equal opportunities
One of the female engineering students (Eng. 05) exclaimed the following:

> *" I think what can be done is allowing ladies and women to do what men do and see if we as women can handle, if not I guess the stereotype will continue, but if we can, there will be less of judgment and more of compliments."*

Two participants further expressed that they desire to be viewed as equals to their male counterparts in the classroom. Another engineering participant (Eng. 06) expressed the following:

> *"Even in the smallest things, maybe the lecturers are like, 'boys follow me, come take these poles', why am I not called? Give me the platform, the opportunity …' Who got the highest in plumbing?' They gonna look at the boys…"*

She (Eng. 06) went further and expressed her view as follows:

> "*I think we should be encouraged more; we shouldn't be treated like we are inferior or something. We should be treated equally."*

One of the other engineering students (Eng. 04) also expressed a desire for equality in the classroom as she shared the following:

> *"Sometimes my lecturer, if I disagree with his opinion or whatever, the things he is teaching us, he is like 'this is man's job, so you mustn't always debate with me' … I think they should give us a chance as women and see what difference do we bring and what can we do more in exchange, and, what can we do, and how are we willing to help and bring change in that time or year."*

An engineering participant felt that in society eyebrows are raised when women pursue careers in engineering, Participant (Eng.03) shared the following:

> *"When I leave home, dressed like this, formal and stuff, they don't tend to look at me like oh you are doing this and this, but when I do, when I wear the uniform the overalls the safety boots and stuff, they start to look at me in another way, like are you really doing this thing? And some of people will really come to me and say are you really working? Or are you just a student? And why did you choose this, cause many girls right now will be putting their manicures and pedicures and here you are… you are dressed as a man, how do you do that?… you know."*

4.3.2 Stereotypes

As mentioned in the literature review, gender stereotypes can be defined as widely shared and accepted beliefs about characteristics that can be attributed to men and women (Gupta et al., 2009; Eagly & Karau, 2002).

4.3.2.1 Stereotypes experienced by engineering students

From the interviews conducted, five of the six participants who study engineering had some experience or came into contact with people who believe in the stereotype that women are less capable than men to study engineering. Participant Eng.05 came into contact with the stereotype suggesting that men are physically stronger than women and therefore more capable to study engineering. When she was asked if she ever experienced stereotypes that suggest that women are less capable than men to study engineering, she replied:

> "*Yes I did, 'cause most people think that we as ladies can't manage to do hard labour work. They think it's only good for men to do that hard labour work, and it doesn't matter, a work doesn't have to matter about gender or anything else as long as you know how to do it."*

Participant Eng.02 answered in the affirmative when asked if she experienced stereotypes that suggest that women are less capable than men to study

engineering. When asked what type of stereotypes she encountered, her response was as follows:

> "*Uhm, it's not for girls, welding is not for girls, you gonna get burned, you gonna lose your fingernails and whatsoever. Ja , those are the type of stereotypes that I experienced.*"

This stereotype that participant Eng.02 encountered challenged the competency of women in this workplace and suggested that she might harm herself due to incompetence. It also suggests that women are fragile and could therefore pose as a safety risk as experienced by participant Eng.06.

Participant Eng.06 is of the view that women are stereotyped as less competent than men in engineering workplaces and therefore pose a safety risk in these workspaces. She was asked if she feels that stereotypes that suggest women are less capable than men to do engineering still exist in society and she had this to say:

> *"I think they still do exist because when you see construction workers on-site, it's mostly men. So you be consider safety, I feel like the first thing is safety, because I feel they think that women are too gentle, too I don't know…submissive. So it's like no, you don't belong there."*

Participant Eng.03 experienced stereotypes in her family, such as cultural stereotypes with assigned role expectations for each gender. When she was asked if she feels that stereotypes exist that suggest that women are less capable then men to do engineering and if it influenced her in any way, she said:

> "*Yes, they do exist…They do feel it's for men, but it's like what's been said. So long ago, like that time, long, long, long ago. Because having a child was meant for women. Those stories still exist, even in our families…ja….. Actually, it did, my dad did mechanics, so… in our family, like most of the men that do engineering, then women are like, my sister is doing accounting, so they also thought that I was going to take those careers, like*

the office type, you know, so I didn't, I just told them that I am going to do engineering and they didn't like the idea."

During the interview, participant Eng.04 shared her observations of stereotypes in her classroom:

> "*Ok, right now in my class we are only three girls and every time when we not, maybe one of us is absent, they won't ask why she was absent yesterday, they will continue and teach, but if one of the guys is not at school they will like ask, where is he? Tomorrow like why weren't you at school then they will tell him, no we were doing this, 1, 2, 3 for a girl they won't do such, so I think its best they focus on both sides and balance, yes.*"

Bandura and Bussey (1999) indicate that in recent years vast changes have been witnessed in the roles women perform but socio-structural practices lag far behind. This statement concurs with the response from participant Eng.03 who experienced cultural stereotypes in the family about engineering even though she managed to enrol for the desired course in the engineering discipline.

Bandura and Bussey (1999) elaborate on the slow change witnessed in organisational practices as beneficiaries build the privileges into protective organisational processes and structures. This is especially true for women in traditionally male occupations who are viewed as incompetent and in comparison to men and are excluded from informal networks and activities. The points touched on by Bandura and Bussey are evident in the responses from the engineering participants. Even though vast changes have been witnessed, in that women are enrolling for engineering courses, these engineering participants have experienced stereotypes in their organisational structure that challenge their competence. They are viewed as physically weaker than men (cf. Eng.05, Eng.02, and Eng.06) and they feel excluded from the class network as mentioned by participant Eng.04.

4.3.2.2 The view on stereotypes from the perspective of Business Studies and Hospitality participants

When the Hospitality and the Business Studies participants were asked if they felt that gender stereotypes exist in our society, most acknowledged the existence of the stereotypes but said that it did not affect them directly in their current fields of study. However, these Business Studies and Hospitality participants were aware of the stereotypes suggesting that men are more capable of doing engineering than women and that it might have affected their career choice.

Participant (B.S03) shared the following view when asked if she feels if gender stereotypes exist and if this influenced her in any way.

> *"Ja, they do exist…uhm but it didn't affect me."*

Participant B.S 01 expanded on the same question and commented:

> *"Yes, they do, they actually do, cause people, actually men actually think that maybe women don't have much strength to be able to do these kinds of things. So ja, I think it exists…Ja, on the business side, I don't think so, I think things are not as much as engineering, there's basically more women in business studies, cause its basically theory stuff about numbers, so it doesn't affect so much."*

When asked about the existence of stereotypes and how it influenced her, Participant Hosp.03 replied as follows, as she was previously enrolled as an engineering student at Molapo Campus. She talked about the stereotypes she experienced as an engineering student in the past but did not mention anything about gender stereotypes experienced as a current Hospitality student. She said:

> *"A lot of people used to say I can't handle the workplace itself, there's too much noise, there's too much work… heavy work, handy work. You know you can't handle the chemicals and the oils and greases there. Yes, they said 'no, you should stick to*

like doing office work'…they make women feel inferior, yes … you feel very inferior."

The Business Studies and Hospitality students noted the existence of the gender stereotypes for engineering studies and careers. But in their current field of study they do not experience gender stereotypes. Their acknowledgment of the existence of gender stereotypes for a career in engineering could have been a reason why they did not choose a career in engineering. According to Bandura and Bussey (1999), occupational choices are of considerable importance because they structure a major part of a person's identity and determine one's quality of life. According to them, self-efficacy beliefs "set the slate of options for serious consideration." Those with a strong sense of self-efficacy consider a wide range of occupations whilst others rapidly eliminate classes of vocations regardless of the benefits they may hold due to efficacy beliefs. The results from this study align with Bandura and Bussey's (1999) argument that these learners might have eliminated the consideration of a career in engineering based on the gender stereotypes that they say they were aware of.

4.3.2.3 Stereotypes and effect on capabilities

From the interviews conducted, five of the six participants who study engineering had some experience or came into contact with people who believe in the stereotype that suggests that women are less capable than men to study engineering as indicated in the previous section (cf. 4.3.2.1:. Stereotypes experienced by engineering students). However, in spite of this, these engineering participants were still motivated to pursue the careers they had chosen. This came to the fore in the interview with all six of the engineering participants of the study.

The first three of these engineering participants shared the sentiment that women too could do engineering despite the different stereotypes they face suggesting that the engineering world is better suited for men. The following was expressed by one of the engineering participants (Eng. 05):

"The reason why I chose to study engineering is because I have a bigger picture of making a women empowerment of construction because most of people think that only men can " *do this construction. So just to reduce those negative thoughts and negative rumours, I thought I could have that little picture and change South Africa for girls."*

Participant Eng.06 who also shared the sentiment that women could do engineering despite the different stereotypes they face which suggested that the engineering world is better suited for men. When she was asked if she felt that gender stereotypes affected her sense of capabilities and how she overcame it, she said:

"I don't think it did because I am very stubborn, you'll tell me I can't do this and I will want to do it, even in class they will be like no you can't carry this, I will try to carry it even if I have to poke my eye while trying walk around with this steel thing, I will do it. So I don't think I'm influenced by what other people think. It's just that other women are influenced. It's just like when someone tells you, you can't do this, you will be like I can't do it too. So I don't think I'm like that, I'm very strongly opinionated, to influence me or to convince about something I am totally against.

This same question was posed to participant Eng. 02. Her response was as follows:

"Yes, yes I was [affected] *and I was like you know what, I'm just going prove them wrong. This is not for men and I just went for it… Yes, it did, they pushed me to do engineering so much, and prove them wrong it's not for men only, anyone can do it, yes."*

Participant Eng.01 also felt that she was not affected by existing stereotypes. She answered:

"…Ja, do feel that it exists… No, it didn't [affect me]*."*

Participant Eng. 03 shared a novel view on why she chose to study engineering. She indicated that she wants to inspire women and act as a role model for them. When she was asked if she felt that gender stereotypes exist and if it influenced her sense of capabilities in any way she responded with the following:

> *"Actually, I wasn't stereotyped in a way, I turned the stereotype into motivation because if women are less in that industry or trade, I took it as if I could be more of an inspiration for other females who don't feel comfortable being in that industry, cause there are female drivers who also do like drive trains and stuff."*

Participant Eng.04 felt that she wanted to pursue her passion when she enrolled in the engineering course. She was also asked if she felt that gender stereotypes existed and if it affected her sense of capabilities in any way, and she responded with the following:

> *"Yes, it did because it's in your heart, it's in your mind, what you wanna do, there's no work that says it's for men or for ladies, as long as you have passion to do what you want to do, you can do it if you want to."*

The data indicates these women are persistent in their pursuit to become engineers despite the difficulties and discouragement they have met because of stereotyped mindsets in society. According to Betz and Hackett (1997:385), a high self-efficacy in a certain field such as academics allows an individual to consider pursuing a career option. When faced with adversity, the individual perseveres in the educational programme for the chosen field. In this study, these engineering participants displayed a high or strong sense of self-efficacy through their perseverance to continue their pursuit to follow an engineering career despite the discouragement that they encountered.

However, it is important to note that not all of the participants used the language of "self-efficacy" in the same way as Bandura. As indicated by Bandura and Bussey

(1999), women who take a more egalitarian view toward the role of women, display a higher sense of self-efficacy for traditionally male-dominated occupations. This was demonstrated by all six participants who are determined to continue their studies irrespective of the stereotypes they have encountered. This was particularly evident in the response of Participant Eng.01 who acknowledged the existence of stereotypes but said that it did not affect her. The participants indicated a desire to pursue engineering careers despite the gender stereotypes they encountered (cf. responses of participants Eng.05, Eng. 06, and Eng.02). One participant had a novel response: she wants to inspire other women to pursue their dreams which is why she opted to study engineering. Participant Eng.04 expressed her passion for a career in engineering and wanted to pursue her passion.

4.3.2.4 Age as a factor in developing self-confidence

Although five of the six engineering participants expressed that they experienced and somehow overcame the stereotype suggesting that women are less capable than men to do engineering, four of them held some belief to this very stereotype when they were younger. When they were asked about their sense of capabilities to do engineering when they were young girls, four of the six engineering participants indicated that they did not consider careers in engineering as young girls. Participant Eng.03 commented:

> *"When I was young, I didn't even think of engineering as a career…I always thought I was going to be a doctor or something… like kind of something medical not engineering."*

When participant Eng. 02 was asked how she remembers developing her sense of capabilities and if she felt capable of doing engineering at a young age, she responded with the following:

> "*Uh, I didn't think that there was something like engineering and stuff, I always thought that when I grew up, I am just gonna be a nurse or a teacher and that's it. But as I grew older, that's when*

I was more exposed to engineering, and that there is something called engineering and that you can work with your hands, ja."

Participant Eng. 05, also an engineering student, was asked if she felt that she was capable of doing engineering when she was a young girl. She answered:

"No, I didn't, I had the stereotype that engineering is for guys when I was younger".

When participant Eng. 06 was asked how she remembers developing her sense of capabilities and if she wanted to do engineering as a young girl, she responded:

"I had other options and everything, of course, when you are young you don't think of such things, but when I saw I was actually interested in how thing are done, how these things work like this, I started thinking maybe I should look at other career choices and then I went to technical school."

As children develop cognitively, they are taught to categorise themselves as male or female according to the social cognitive theory of gender development and differentiation (Bussey & Bandura, 1999). As soon as self-categorisation takes place, according to Bussey and Bandura, one's gender status could carry significance not only to dress and play, but "occupations pursued and functions performed in family life" (1999: 696). This could explain why, as young girls, the four engineering participants did not consider careers in engineering as they have categorised themselves as young girls in a society which deems careers in engineering as inappropriate for women. Furthermore, Bandura and Bussey (2004) elaborate on the fact that infants and toddlers are shaped and told what is appropriate for their gender and not their self-efficacy. This, they indicate, is done by structuring an environment for them and reacting differentially for gender-linked behaviour. However, the more self-knowledge and self-appraisal skills children acquire, the beliefs they form about their capabilities exert an influence on their development. Because of their limited cognitive skills, young children have "sketchy" knowledge of their capabilities, have difficulty in distinguishing between

minor and important indicators of capabilities and are unable to benchmark their abilities against those of their peers. The results from this study support this as four of the six engineering participants did not consider a career in engineering as young girls as they were unable to measure or understand their capabilities when they were younger and they formed part of the environment that their parents created for them on what is acceptable gender-appropriate behaviour.

4.3.3 Self-efficacy

Self-efficacy can be explained as the belief one has in oneself to achieve something (Bandura, 1994). All the participants in the study were questioned concerning their sense of self-efficacy and their development of their sense of capabilities.

4.3.3.1 Self-efficacy explored amongst the engineering participants

As this is an investigation into exploring the underrepresentation of females in engineering studies at TVET Colleges, the six engineering participants were asked if they felt that a strong sense of self-efficacy contributed to career choice.

Five of the six participants that study engineering agreed that their strong sense of self-efficacy contributed to their decision to choose engineering as a career path. They felt that they had the capabilities required to pursue a career in engineering. The engineering participant (Eng.06) described a novel way of developing a belief in herself, which was not mentioned by Bandura. She said:

> *"…Because you cannot do something when you don't believe in yourself, then what's the point in doing it? So, I don't think, I believe and I know. I will not believe otherwise because I see someone else not actually progressing. So I feel like I can do it, I can do it, there's no other way of going around it. That's just how it is."*

Another engineering participant, Eng.03, described her experience as follows:

"*Cause if ever I did not know my capabilities or how I feel about them, I wouldn't choose it* [engineering]*. Cause firstly if you choose a career you must know your strengths and your abilities and weaknesses."*

Participant Eng.04 responded affirmatively when she was asked if she felt that a strong sense of self-efficacy could have encouraged her to pursue a career in engineering. It should be noted that when I used the language of "self-efficacy" during the interviews, different participants gave it a slightly different meaning in their answers. Eng.04 spoke of a "passion" and was able to develop confidence in the face of people who discouraged her as follows:

"I really have one [a passion]*, because some of the girls I met every day, I met people who will discourage me. So I'm like its fine, I'm a girl, I can do engineering whenever I want and I don't care who says what as long as I've got passion. I woke up every day with self-confidence, I can go to school every day and study whatever you wanna study, you will succeed at the end."*

Moreover, this particular participant, Eng.04, did not believe in the stereotype that engineering is mostly for men when she was a young girl. When she was asked about how she felt about her capabilities when she was younger, her response was as follows:

"I chose to study engineering because since I was young I liked to play with boys' toys, so I thought about ok, why every time I play with toys, like cars you know. So one day I got in a car accident, I didn't know how and when, why, thought about okay, I wanna study about cars. Yes, so I thought let me go and study mechanical engineering, and one day I wanna design my own car. Yes, so that's where I realised that mechanical engineering is my thing."

Participant Eng.01 was asked if she felt that a strong sense of self-efficacy had encouraged her to pursue a career in engineering. She answered:

> *"Yes. I feel it could, like the way I feel the way I can do this I will be able to finish this career. I will be able to do it"*

Likewise, participant Eng.02 attributed a sense of self-efficacy to why she pursued engineering as a career. She replied as follows:

> *"Yes, yes I have that… I think it pushed me to do this engineering thing."*

The above-mentioned responses from the participants Eng.01 and Eng.02 indicated that they feel that their strong sense of self-efficacy is what led them to pursue a career in engineering. Perceived self-efficacy can be termed as the belief one has in the ability to achieve something. "These efficacy beliefs influence how people think, feel, motivate themselves, and act" (Bandura, 1994:1' section 2.3.2.1). Participants Eng.06 and Eng.03 expressed their strong beliefs in their capabilities and their ability to distinguish between their weaknesses and strengths enabled them to pursue a career in engineering. Their belief in their capabilities to achieve something is understood as synonymous with self-efficacy as termed by Bandura (1994). Therefore, their self-efficacy could have encouraged them to pursue a career in engineering. As indicated above, different participants understood and expressed their opinions about "self-efficacy" slightly differently. Participant Eng.04 underscored that she has "passion" and was able to develop confidence in the face of people who discouraged her. According to Bandura and Bussey (2004), efficacy beliefs influence the occupations that individuals seriously consider, the interest they have in them, and their resilience in pursuit of careers that are considered challenging. Participant Eng.04 displayed resilience as indicated by Bandura and Bussey as a result of her efficacy beliefs (cf. Betz and Hackett 1997:385; section 2.3.2.2). Participant Eng.04's strong sense of self-efficacy has enabled her to persist with her studies in engineering despite the discouragement she faces.

4.3.3.2 Development of a sense of capabilities

The engineering participants were asked how they remember developing their sense of capabilities. Five of the six participants recalled that they had the ability or displayed a technical interest at some stage in their lives. Four of the six participants recalled that they believed in the stereotype suggesting that engineering is for males when they were much younger (cf. 4.3.2.4). However, as they matured, four girls adopted a different view of engineering as is seen when they were questioned about how they felt they developed their sense of capabilities. The responses of these four participants will be explored first, followed by the responses of the other two who felt capable of pursuing careers in engineering as young girls. All six engineering participants, at some point, became aware of a technical interest and felt that they had the capabilities to pursue careers in engineering.

Participant Eng.02 (who had believed in the stereotype that engineering is for men) responded as follows:

> *"It started at a young age, I used to be that girl that, whenever something is at home like a heater or something is broken, I just take the screws, the screwdrivers and just start, you know fiddling with things even if it didn't work after, but I was trying. Ja it started like that. … If it wasn't for it, I think I would have stayed in that high school doing history and stuff and I'd always be scared, no I'm gonna lose my fingernails and that.. you see, and things like that, so I think I do have a strong sense of self-efficacy."*

Participant Eng.03 (cf. 4.3.2.4) first did not consider engineering as a career when she was younger. When asked about her later choice, she responded as follows:

> *"When I was in grade 11 when I was doing physics and we went to Braamfontein, then I saw two girls who were in this engineering, civil, thing, so like I asked them questions, why did*

you choose this career and stuff? And they said, I didn't choose it because I saw it from someone else, it's just a passion that I have, ok then I understood it, I got to research it more, I went to Nelson Mandela's bridge, and that's where I got the inspiration…I used to draw a lot at school, so you know in physics you do draw, so when I started to see the books, I just thought I could do it."

When asked about the same topic, participant Eng.06 answered:

"I had other options and everything of course, when you are young you don't think of such things, but when I saw I was actually interested in how things are done, how these things work like this, I started thinking maybe I should look at other career choices and then I went to technical school. And then I learned more about civil engineering which is actually fun."

Participant Eng.05 was also questioned on her development of a sense of capability to do engineering as a young girl. She responded:

"The thing was, coming here, it was just to get more information, I wasn't that passionate about engineering but after my first term marks, I started getting interested and trying to see if I can do it. But I know I can it's just that I didn't have that hope. The thing is, I had a better picture, it's just that my dream career was to be a nurse. But then I couldn't get to do nursing so I said I should just go and do engineering cause my maths was okay and finally I got accepted. Here I am."

The next participants indicated that they felt capable of doing engineering when they were young girls. Unlike the others, they had never embraced the stereotype that engineering was for males. Participant Eng.04 said:

> *"Yes, I was younger, I think I was 15 years old when I got in a car accident, and I didn't know anything about a car so I was always asking myself, what is it that was in the car that I can make it and design a new engine for a new car. And I was like I'm still young, can I have time and go back to school and do what I want, and maybe if it's working I can bring change in the whole world."*

Participant Eng.01 related her belief in her capability to her home and to the encouragement of a family member. She said:

> *"Yes, I did, because when I grew up I always heard about engineering, people told me about it, and was like, ok, I think I must try it, then finally this uncle came to me and told me there's this course at this college and I thought this is my opportunity… so I'm gonna do it and see how it goes."*

At some point, later in the lives of these women, a conscious decision was made to pursue engineering as a career. Four participants had to overcome the gender stereotype they believed in concerning a career in engineering when they were younger. In spite of this, they developed their interest in engineering and they believed that they were able to pursue a career in engineering. Bandura and Bussey (2004) state that the self-efficacy of toddlers are created or influenced by their parents and the environment that they create for them; However, as individuals grow older (Bandura & Bussey 2004), belief in one's efficacy shapes the course of development by the activities and social environments individuals select. Efficacy beliefs influence the occupations that individuals seriously consider, the interest they have in them, and their resilience in pursuit of careers that are considered challenging. This view is supported by the results of this study as four of the six engineering participants were able to identify their interests and pursue the careers they desired despite the stereotype they believed in when they were younger (Eng.05, Eng.06, Eng.03 and Eng.02). Bandura (1997) notes a sense of self-efficacy can be developed by noticing/observing one's success – as long as this is rewarded/admired. By practically noting their ability (note the

response of participant, Eng.01 who developed self-esteem), the participants chose engineering. Fortunately sufficient people in society admire women (or anyone) with technical aptitude. Eng. 01's family accepted her and her interest. This encouraged her to realise her skills and she thus developed a sense that she would not be restricted to a predominantly "male" occupation.

4.3.3.3 Self-efficacy explored among participants who study Business Studies

As this is an investigation into the reasons for the underrepresentation of women in the engineering fields of study at the TVET Colleges, the Business Studies participants were asked if they would consider careers in the engineering field. Two of the three participants indicated that they remember developing a strong sense of their capabilities when they were younger and felt capable of pursuing careers in engineering when they were younger. All the Business Studies participants shared positive feelings toward their counterparts who were studying engineering and felt that they are a motivation to others.

B.S 02 indicated that she would have loved to be one of them, but her results at schools hindered the choice to pursue that career. She said:

> *"They are such a motivation and I wish I was one of them actually because the situation doesn't allow, for now... we don't know how things might just turn out…But for them to keep it going, yeah."*

Participant B.S 01 made the following comment when she was asked her opinion about women who study engineering.

> "*I feel like, ja, from my perspective, I feel like they are strong because they were not discouraged by what other people thought about the engineering stuff, so I think they are very… they had the courage to do whatever they wanted to do despite*

what people say around us. About women not being able to be part of engineering career."

Participant B.S. 03 shared this view about engineering as career option:

"I think it's a good choice if you go for it, it is that there are less women in this field, it… also opens more opportunities for young girls to be willing to learn about it."

Two of the three Business Studies participants indicated that they felt capable of studying engineering when they were younger. Participant B.S 03 explained:

"I think maybe it's due to my past failures, like I said science was not for me, so I just decided to change to go for something else, ja, and I'm doing way better in this than in science."

When participant B.S 02 was asked how she remembers developing her sense of capabilities as a young girl and how this related to pursuing a career in engineering, her response was as follows:

"I did, remember I did tell you… I thought I wanted to go into that industry, if it's not health, it was engineering. With civil engineering, I knew it wouldn't work for me because at that time they used to tell us it's more about drawing and stuff. So I thought maybe that's not for me, maybe something else in engineering, because I loved science… I've always been a very confident person, especially academically, but then grade 11 and 12 showed me flames. And then I was like maybe I shouldn't be confident after all hey because they showed me flames."

Participant B.S 01 shared the following:

> "*I knew I could do it, but the problem is the science. I always liked engineering when I was in high school, I actually wanted to do chemical engineering but couldn't do it because of my marks.*"

Two of the three Business Studies participants felt that they had a strong sense of self-efficacy and felt confident in their capability to pursue a career in engineering when they were younger, but their Mathematics and Science results prevented this. Huang (2013) conducted a quantitative meta-analysis of 187 studies containing 247 independent studies on gender differences in academic self-efficacy. The results indicated that females display higher academic self-efficacy for language and art. Males, on the other hand, display a higher self-efficacy, for mathematics, computer, and social sciences. He also found that gender differences in academic self-efficacy vary with age. For mathematics self-efficacy, significant gender differences are displayed in late adolescence. The findings of this study are in line with Huang (2013). The Business Studies participants felt that they were able to pursue a career in engineering when they were younger but when they reached secondary school (adolescence), their performance in Mathematics and Science dropped. As a result they were unable to pursue careers in the engineering discipline.

4.3.3.4 Self-efficacy explored amongst the Hospitality students

All three of the Hospitality participants who participated in this study were asked if they would consider pursuing a career in engineering and all three hospitality participants answered negatively.

However, these participants shared positive feelings toward women who were studying engineering and felt that they are a motivation to others. They felt that those in pursuit of these careers have a passion for it as engineering is a challenging career mentally and physically. Interestingly, one participant, Hosp. 03 studied engineering before she commenced her studies in hospitality. She said when asked how she felt about women who are pursuing careers in engineering:

“I feel something very great. It’s a good thing to do as an individual and it’s a challenge, great challenge.”

When participant Hosp. 02 was asked how she felt about women who pursue careers in engineering, her response was the following:

“*I think they are well matured or what can I say, they are more wisely, they know what they are doing.”*

When participant Hosp.01 was asked about her view of women who pursue careers in engineering, she responded as follows:

"I could say they are facing most things normal women wouldn't do… The negatives are the heavy stuff you are going to have to carry; maybe they are going to affect you as you grow older… And the positives are getting much information about they wouldn't have to call "First for Women" in case they have a puncture or they need to change their tires or something like that.”

During the interviews, these Hospitality participants were asked if they could remember how they developed a sense of their self-efficacy when they were young girls and if they ever wanted to pursue a career in engineering. Participant Hosp. 03 (who previously studied engineering) replied:

“It started with me loving a lot of different cars, yes a lot of different cars, different good cars and I thought I could do it…. I don’t wanna go there because I have a challenge I Maths, but if I could, I would go back and do it.”

This same question as mentioned above was posed to the other Hospitality participants. Participant Hosp. 01 responded with the following.

"*No, I didn't… I wanted to be a nurse… I was so adamant about it.*"

When participant Hosp.02 answered the question as follows.

> *"Because since I've been in here, I can see my weaknesses onto it, I can see my strength. Because I'm trying a lot to get what I want. So I know sometimes where my soft skills and my hard skills, where it goes. So that is why I'm willing to get what I want…I think if we can have that thing, that we want to be in engineering it must come through your heart…because you know yourself. I cannot run for engineering, for me, Maths is difficult, to me all that multiplication and whatever."*

When participant Hosp.01 was asked if she was influenced by stereotypes which suggest that women are less capable than men to study engineering, she said:

"*Yes, I could say that… My brother used to say that a car is not for women. Women don't know anything about cars, they only belong in the kitchen, so.*"

When I asked her if she believes this, she replied:

> *"Yes, sometimes I do because when he told me about brake disc and all those things, I saw that ah... This is not for me."*

Participant Hosp.02 was asked if she was in any way influenced by stereotypes which suggest that women are less capable than men to study engineering. She said:

> *"Yes, I feel it because it's a lot for me, but I think in… when time goes, maybe I can change my mind and go do it because anyway I liked, you know… technology"*

Participant Hosp. 03 was asked if she was in any way influenced by stereotypes which suggest that women are less capable then men to study engineering, she referred to the time when she was still an engineering student herself:

> *"A lot of people used to say I can't handle the workplace itself, there's too much noise, there's too much work… heavy work, handy work. You know you can't handle the chemicals and the oils and greases there. Yes, so they said 'no, you should stick to like doing office work'… They make a woman feel inferior… yes you feel very inferior."*

Most Hospitality participants said that their marks for Mathematics and Science did not allow them access to engineering otherwise they may have been interested in this. They admire female students who are pursuing such a career.

As indicated previously in the literature review, according to Smeding (2012:617), stereotypes can undermine the self-perception of women and girls concerning their abilities, performance, and even interest in pursuing a career that does not fall in the confines of the stereotype of masculine-defined work. The findings confirm this. The marks of the Hospitality participants were not high enough – The question can be asked whether they were given as much attention as the boys and if so could have had better marks. This is what many feminist authors argue: teachers tends to give more attention to boys as they expect them to be better. From my interpretation of this study, I think these participants might have had an interest as they did express that they admire the students who were doing engineering. Fogliati and Bussey (2013) found that the effect of stereotype threat on women's mathematical performance is potentially compounded by its capacity to reduce motivation to improve. This concurs with the fact that the Hospitality participants were probably not motivated to improve their marks in Mathematics due to the discouragement they experience linked to gender stereotypes.

4.3.4 Lack of information or education

A theme that came across strongly in this study is a lack of information or education. Five of the six Engineering participants, the three Business Studies participants and the three Hospitality students explained that many people are unaware of what a career in engineering entails. Furthermore, potential students lack information about pursuing these careers through learning institutions such as TVET colleges and about the pre-requisites for the different courses offered.

The following responses were given by the five engineering students when asked about what platform TVET colleges should use to encourage women to pursue careers in engineering: Participant Eng.03 said:

> *“I think if they don’t just do, if they don’t just inform us students that are here, if they could do maybe some notice things, or promoting things outside the college, maybe in the community halls and stuff, invite all the girls and stuff, from this campus and stuff or from other campuses, or just community girls and stuff here around then after they should do, they should inform like about the career, how it is and stuff.”*

Participant Eng.02 commented:

> *"I feel that they have to create programmes that can invite women to learn more about these things to let them know that it's normal and anyone can do it and that you have to know what you are doing and that you have to be determined. And maybe some girls don’t know about these things. They think it's for males only so they just need to be educated*."

Participant Eng.05 said:

> *“They could even do just a what do you call it, a gathering, a smaller meeting whereby they could invite women and then, women can get smaller motivational speeches and people who*

did civil, and then they now owning businesses just to encourage them."

Participant Eng.01 said:

"Like if most women get together and speak to each other, maybe they will also get the idea that okay, she's doing it, maybe I can also try, that's how they will get there…Ja, sharing information with them telling them how it is, how it goes ja,… I mean they will also feel let us see how this is let's try it out, maybe we can do it."

Participant Eng.04 commented:

"*They should, I think they should also do adverts ja they should do advertisement for women, that they also can also do that like it's not only for men, they must encourage everyone like everyone has a chance, they mustn't like exclude everything from women and focus only on men."*

During the interviews, the Business Studies participants were also asked about what platform TVET Colleges should provide to encourage women to pursue careers in engineering fields. The participant based at the Dobsonville Campus, B.S 02 shared the following in the interview:

"Well, with me…because I didn't have much information about the college, the Molapo Campus until I was part of SWGC… So I think that's one of the things that could contribute, there's not much information that tells us that there's a Molapo Campus that offers such, for both women and men…we don't have people who are close to us who encourage us about the whole industry thing and tell us that actually there is a Molapo Campus in Soweto, we don't even know that we have that in Soweto. If

people knew there was a campus such as this, they would be attracted and feel that we can actually do this."

Participant B.S 03 commented:

"Maybe if the school could bring people, speakers, to speak to learners, because I haven't seen anything from outside or wherever, encouraging learners, not just in science but in everything, just to talk to us…"

Participant B.S01 said:

"Oh, by like making programmes where you can elaborate how these things work…how engineering has different platforms… how just making things be interesting for them to be like 'oh, this I can do' Maybe like going to other schools where there's girls only."

During the interviews, the Hospitality learners were also asked what platform TVET Colleges should provide to encourage more female learners to study engineering. Participant Hosp.02 responded to the question as follows:

"I think they should go through socially on TV's on radio to the media, yes. So that they can know what is at the TVET Colleges."

Participant Hosp.01 said:

"I think they should talk on social media. Because everyone reads on social media these things, on radios, on billboards."

Participant Hosp.03 shared the followgwing view:

"The lack of information I think, those are the barriers. The lack of information that we get from the school from the college… they don't give us like a lot of information to learn from and to know what to do from now to move forward…To promote, I think… we do have pamphlets but even the students could contribute to that… into educating people, yes outside and tell them here at TVET College we got certain subjects and if you are interested in this and that, you can feel free to come and register, we offer this in this kind of career and this and that…if they can do that."

The responses indicate a lack of information about a career in engineering, the career benefits and the pre-requisites needed to pursue a career in this field. People are not aware of the institutions that offer these types of courses, especially in the TVET sector. Better marketing in this regard could encourage more women to study engineering at these institutions. Marketing and branding should be void of the stereotype that engineering is exclusively for men, should promote engineering for women and should target all-girl schools in particular. More women should be invited to attend and to address individuals at awareness campaigns held in communities.

4.3.5 Influence of Mathematics and Science marks of learners at TVET Colleges

From the interviews conducted every participant indicated that her Mathematics and Science marks influenced her career choices. Most participants were negatively affected by poor results for Mathematics and Science. All of the Business Studies and Hospitality participants said that their Mathematics and Science results affected their career choice. The Business Studies participants indicated that they desired to pursue other careers at other institutions but could not do that because they did not have the desired marks for Mathematics and Science for acceptance into these institutions. In this regard, Participant B.S.02 shared the following in the interview:

”It actually made me change from what I initially wanted to do. I wanted to do pharmacy, cause my marks like dismally dropped from grade 11 to grade 12, hence I failed physical science and my maths. They were one of the things that made me not get my matric certificate.”

Participant B.S.03 went on to say:

"I wanted to do biokinetics in UJ but then I didn't qualify because of the APS score, they needed level 5 which is 60 for both Maths and Science, so… that was it. Then I tried to upgrade the recent marks, but then there was still no difference there, I'm like let me just change into finance or something different.”

Two of the three Hospitality participants also indicated that they would have preferred to pursue other careers when they were younger, but their results affected them negatively.

The experiences of the Business Studies and Hospitality participants exemplify concerns raised by the UNESCO (2015) report. This report reveals that negative gender stereotyping disadvantages secondary school girls with regard to Mathematics and Science achievement. If this is not addressed at the secondary school level, it affects later studies or careers chosen by girls as Mathematics and Science are required to pursue STEM careers. As already mentioned, Fogliati and Bussey (2013) found that stereotype threat on women's mathematical performance could be linked to reduced motivation to improve. This was confirmed in this study and is a reason why women are underrepresented in engineering.

4.3.6 NCV as a practical course

In 2007, the NCV programme was introduced as a 3-year programme, namely Level 2, Level 3, and Level 4 which has a practical component for all the vocational subjects. This programme aimed to expose learners to the practical aspect of their occupation before they enter the workplace (DOE, 2006). The NCV certificate opens doors for further training at the TVET College (N4-N6) or students may gain

access to universities with the required technical background as an advantage (DOE, 2007).

Participants were asked why they chose to do the NCV programme instead of the NATED course. Some indicated that the results that they obtained in other institutions did not allow them entry into the NATED courses as was explained earlier. Other participants felt that the NCV course offers basics that the NATED courses does not offer, it was a little easier and had a practical component that they felt was beneficial. Other participants felt that the year course of the NCV placed less strain on them than the NATED trimesters (four months) would, and therefore considered it a little easier. Some Engineering participants saw the NCV programme as a way to achieve their "technical matric".

4.3.6.1 NCV course and the provision of Basics

The study indicated that many participants, whether they are studying Engineering, Business Studies or Hospitality, opt for the NCV programme because they feel it offers basics training that they might be lacking which could better prepare them for the workplace. The Engineering participant (Eng.05) said:

> *"The reason why I came here it's because of like at TVET College you have like NCV where you start the engineering from the scratch, unlike in university, in university you get like, you don't get the… the basics, you get the hard picture of engineering so I decided to just start it from scratch to understand how it goes, so when I'm there I can have a picture of how I'm going to approach the studying to get distinctions and all that…"*

Participant Hosp.02 shared the same sentiment about mastering the basics when she was asked why she registered for an NCV course and not for the NATED course. She said:

"Because I want to start from the basics. I must get the basics from hospitality."

Similarly, Participant Eng.06 commented:

"It offers more because if I'd jumped and went to Rapport 191, I would have struggled down the line. There would have been more pressure put on me, so it's better to start things at level one and then go up."

4.3.6.2 Practical aspect provided by NCV course

Participants felt that the NCV course offers a practical aspect that the NATED courses do not offer and they could benefit from this. Once again, this applies to Engineering students, Business Studies students and Hospitality students. Eng.03 indicated that she prefers the practical aspect that the NCV course provides:

".I chose to study here because at varsity I felt there were no opportunities especially the practical part of them, when I came here I didn't choose the NATED one because…it was a new thing to me, so I just chose to do level 02 just to understand the whole trade. How it's done."

The practical aspect also appealed to participant Hosp. 01 who said:

"I registered for the NCV programme because it has more information than the Rapport 191. Because the NATED one only consists of theory, there's no practicals. It's not much as it is in NCV."

Participant B.S.03 shared the same sentiment:

"No, it's just there's more practical's right?"

Some of the Engineering participants came from technical schools and were working towards a technical matric, which is what the NCV programme offers. Eng.02 explained why she chose to enrol at a TVET college:

> *"To get more experience and practical works so I can be able to know what I'm doing and to know more about the machines that I'm going to use in the industry, yes it's for the practical aspect…I need my matric certificate, that's all I need… ill continue if I'm willing to do it. At this point, I'm not sure if I'm willing to continue or not, when I get to level 4 I'll be clear on what to do."*

Participant Eng.04 concurred:

> *"Because I registered for the NCV because it has a practical and mostly, sometimes it's hard for me to learn from the book without seeing, touching, or practicing what I'm learning about. Yes so like I felt it will be easy, no matter what how much time it takes but as long as I work hands-on it's fine for me."*

These comments indicate that learners appreciate the practical aspect of the NCV Course for which it was originally designed. According to the DOE (2006), this programme aimed to grant learners exposure to the practical aspect of their occupation before they enter the workplace. The results from this study concur with Powel and McGrath (2014), who found TVET Colleges offers a better learning pathway or programme to practice. They found that in their study some learners explained that the college programmes offer a mixture of theory and practice. Some learners left school after completing Grade 9 to pursue the NCV programmes of choice and the NATED programmes afterward in an attempt to pursue their desired careers according to their study.

4.3.6.3 NCV – A year course

From the interviews conducted, it was also found that one of the participants enrolled for the NCV course because the duration of the course is for a whole year,

whereas the NATED courses run for trimesters. She felt that the longer duration made the NCV course less strenuous and slightly easier. Hosp.03 explained:

> *"I thought that it would be easier for me to do the NCV because we have the long term instead of the short terms of doing it, yes. Instead of like three months."*

4.3.6.4 Minimum requirements for NATED Courses not met

Some participants did not meet the minimum requirements for the NATED course and therefore decided to enrol for the NCV course instead. Business Studies participant, B.S 01, explained why she enrolled for the NCV programme instead of the NATED:

> *"It was because I did not pass matric well so I did not qualify for the NATED, so I had to go for the NCV.*"

Participant B.S 02 also was unable to meet the minimum requirements needed to enrol in NATED courses:

> *"Because I don't have my matric, ja, I didn't get my matric, I did try upgrading my marks after matric but it didn't go well."*

Results concur with Powell and McGrath (2014). According to their study, college is a bounded choice; some students completed matric but their results did not allow them entrance into institutions of higher learning. In contrast, other participants had the marks to qualify for entrance into such institutions but financial constraints led them to choose the TVET College as the learning institution to complete their studies.

4.4 Conclusion

This chapter provided an overview of themes that resulted from the analysis of the data that were collected from the semi-structured interviews that were conducted from the participants chosen for the investigation. These six themes: Desire for

equality in the engineering career path; Influence of stereotypes; Self-efficacy; Lack of information or education; Influence of Mathematics and Science marks of learners at TVET Colleges; and NCV as a practical course are possible reasons for the underrepresentation of women in engineering studies in the TVET sector with special reference to a TVET College in Gauteng. I now proceed in Chapter 5 to offer my final synthesis and recommendations.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This investigation aimed to explore some of the reasons why female students are underrepresented in engineering studies at TVET Colleges, with special reference to a selected TVET College in Gauteng. From the data analyses undertaken in Chapter 4, six themes emerged: Desire for equality in the engineering career path; Influence of stereotypes; self-efficacy; Lack of information or education; Influence of Mathematics and Science marks of learners of TVET College; and NCV as a practical course.

The main research question guiding the study was to explore with participants why female students are underrepresented in engineering studies at TVET Colleges. The following sub-questions assisted in exploring some of these reasons:

- What triggered the enrolment of female students for engineering studies at the TVET College?
- What were the reasons for female students to enrol in other courses besides engineering studies at the TVET College?
- Why did the female engineering students enrol in the NCV programme?
- Did these engineering students feel that they had to overcome social obstacles when deciding to enrol in the NVC programme?

5.2 What triggered the enrolment of female students for engineering studies at the TVET College?

Four themes emerged in response to the question that was posed as to what triggered the enrolment of female students for engineering studies at the TVET College. These themes are: Desire for equality in the engineering career path, Lack of information or education, Self-efficacy, and Influence of Mathematics and Science.

5.2.1 Desire for equality in the engineering career path

From the results that emerged from the study, it became evident that the engineering participants expressed a desire for gender equality in the engineering career path. This desire for gender equality could be one of the reasons why they decided to opt for a career in engineering that is traditionally viewed as a male occupation. The inverse of this could also be true; these engineering participants could have this desire for gender equality because they have pursued careers in the engineering field. The study indicates these engineering participants feel that they are viewed incompetent in this traditionally male-dominated field, that they receive no or little support from their peers and they feel excluded from informal social networks in the workplace or classroom. These are the very reasons why they desire equality in the engineering career path.

5.2.2 Lack of information or education

The participants indicated that a lack of knowledge prevails in society about what a career in engineering entails and the opportunities that this career presents. This could be one of the barriers as to why so few women are interested in studying engineering-related courses at the TVET Colleges. The Hospitality participants described a career in engineering as a challenging one, both mentally and physically. The Hospitality and Business Studies participants indicated that a lack of information concerning career options in the engineering career path. One of the barriers for women to not enrol in these courses is that they do not know what the different courses entail or what doors they could open for them in the industry. They indicated a lack of information concerning the institutions that do offer these engineering and related courses, and the pre-requisites such as Mathematics and Science are needed for these courses. If more can be done about the marketing and the availability of such information especially to girl students, as gender stereotypes impact the performance of girls in Mathematics and Science, more women could ensure that they fulfil pre-requisites needed for engineering-related courses.

5.2.3 Self-efficacy

Five of the six engineering participants indicated a strong sense of self-efficacy – although they did not all have the same definition for self-efficacy – was the reason why they pursued a career in engineering despite the gender stereotypes that they have encountered. A strong sense of self-efficacy allows for resilience in the face of discouragement. One of the participants had a novel way of developing a belief in oneself. She explained that if you are unable to achieve something it could mean that you do not believe that you can do so. Another explained that she is aware of her strengths and weaknesses; she explains that if one does not know what you are good at you are unable to achieve what you want to achieve. By knowing her strengths and weaknesses she was able to play on her strengths and believed she could therefore handle the engineering course and her career. Another participant spoke of the fact that she has passion and was able to develop confidence in the face of those who discouraged her. The other two participants felt that it was their strong sense of self-efficacy that encouraged them to study engineering (and allowed them to persevere in their studies despite the stereotypes that they encountered). At some point in their lives, all of these engineering participants made a conscious decision to study engineering even though four of these participants believed in the gender stereotype that engineering is better suited for men when they were young girls.

5.2.4 Influence of Mathematics and Science marks at TVET Colleges

From the results of the study, it was clear that many of the Business Studies and Hospitality participants did express an interest to pursue a career in engineering or something else at some points in their lives; however, their Mathematics and Science results in school influenced their career choices and they did business and hospitality instead. Mathematics and Science results impacted the lives of the participants as some of them desired to enrol for the NATED course (especially the Business Studies participants) but they did not meet the minimum requirements to qualify for these courses and therefore chose to do the NCV programme.

5.3 What were the reasons for female students to enrol in other courses besides engineering studies at the TVET College?

Three themes emerged in response to the question that was posed as to what triggered the enrolment of female students for engineering studies at the TVET College. These themes are the Influence of Mathematics and Science; Stereotypes; Lack of information or education.

5.3.1 Influence of Mathematics and Science

Results indicated that the previous marks that Hospitality and Business Studies participants obtained in Mathematics and Science affected their career choice. Two of the three Business Studies participants indicated that they desired to pursue other career paths but were unable to do so due to their marks obtained for Mathematics and Science. The Hospitality participants showed admiration for women who do engineering and indicated that poor performance in Mathematics and Science prohibited them from entry into many courses including engineering. Their marks for Mathematics and Science prohibited them from pursuing their dream careers and they, therefore, had to opt for their second and third choices.

5.3.2 Stereotypes

All the participants of this study did, to some extent, acknowledge the existence of the stereotype that suggests that women are less capable than men to do engineering. The Business Studies and Hospitality participants did, however, indicate that they are not affected by this stereotype in their current field of study, and have never been in a position where they felt that they were treated as less capable than men to complete a task. This stereotype, nevertheless, could be the reason why some of these participants avoided registering for engineering-related courses. The wider issue of negative stereotyping leaves room for the gender dimension of mathematics and science at the secondary education level against girls. This is also evident in this study as the Hospitality and Business participants were negatively affected by their Mathematics and Science results obtained in secondary school and were unable to pursue their dream careers.

5.3.3 Lack of information or education

The participants of this study indicated during the interview that they felt that a lack of information is a contributing factor as to why females do not enrol in engineering courses. People do not know what engineering entails and that it is not just restricted to one gender. One Business Studies participant also indicated that she was unaware of one of the campuses of the college that she attends in the surrounding areas that offers these engineering courses to the public. The lack of knowledge could be a reason why students register for other courses, besides the engineering courses available. The participants also clearly indicated that they would like to see this information filter through to girl students in schools and in the community. If they see more women engineers addressing them in schools and in the community, they could relate to them and see themselves as future engineers.

5.4 Why did the female engineering students enrol in the NCV programme?

Interviews were conducted with participants to discover why female engineering students enrolled for the NCV programme. The following themes emerged as some of the reasons for this decision: Influence of Mathematics and Science; Practical aspect of NCV; and finally Lack of information or education.

5.4.1 Influence of Mathematics and Science marks at TVET Colleges

Hospitality and Business Studies participants indicated that they chose the NCV programme because the results they obtained for Mathematics and Science in earlier marks at school did not meet the prerequisite needed to qualify for universities or the NATED programme in the TVET College. The Engineering participants also indicated that their Mathematics and Science results did not allow them entry into tertiary institutions such as universities and they were unable to enrol for NATED courses in the college itself.

5.4.2 Practical aspect of NCV

From the results of the study, it was also clear that participants were attracted to the practical aspect that the NCV programme has to offer. The Hospitality students indicated their enthusiasm for doing practicals in their course. The Engineering students also indicated their desire to complete their "technical matric" which is what the NCV programme offers.

5.4.3. Lack of information or education

The participants of this study are not aware of the difference between the NCV or NATED courses and are unaware of the prerequisites needed. They do not know the duration and what the different courses entail, the doors they could open, and what career or vocation they could qualify for with the relevant qualification.

5.5 Did these engineering students feel that they had to overcome social obstacles when deciding to enrol in the NCV programme?

From the analysis of the data of this study four of the six identified themes arise in response to the question posed. These themes are a desire for equality; stereotypes; lack of information or education; and NCV as a practical course

5.5.1. Desire for equality in the engineering career path

The Engineering participants indicated a desire for equality in the career they chose and in the classroom. These participants indicated that they experienced stereotypes in the society about the careers they chose and in the classrooms, however, they managed to overcome these stereotypes to continue with their current studies. Therefore, these participants had to overcome these social obstacles in pursuit of a career in engineering and enrolling in the NCV programme. Bandura and Bussey (1999) concur about the slow change witnessed in organisational practices. This is especially true for women in traditionally male occupations who are viewed as incompetent in comparison to men and are excluded from informal networks and activities. Even though the vast changes have been witnessed, in that women are enrolling for engineering courses, these engineering participants have experienced stereotypes in their organisational structure that challenge their competence in that they are viewed physically weaker than men (as viewed by Eng.05, Eng.02, and Eng.06) and they feel excluded from the class network as seen by participant Eng.04.

5.5.2. Stereotypes

Five of the six engineering participants explained that they encountered stereotypes concerning the chosen career in engineering or in the engineering classrooms. They also overcome these stereotypes (social burden) as they are still registered for these courses and are currently in pursuit of these careers. Four of

the six engineering participants admitted to believing in this stereotype when they were younger but were able to overcome this stereotype and at a later stage in their lives envisioned themselves in a career in engineering. Bandura and Bussey (2004) indicate that when learners are young, their parents create an environment that is gender appropriate for children to grow up in; however, as children grow up, they measure their capabilities against those of their peers and can identify their strengths. As these engineering participants grew older, they were able to overcome this social burden in the form of gender stereotypes that they once believed when they were younger and were later able to identify their capabilities and pursue their desired careers.

5.5.3 Lack of information or education

All participants explained that a lack of communication was a social obstacle when deciding to enrol in the NCV engineering-related programmes. Insufficient information is marketed about what a career in engineering entails and that it is relevant to both men and women. A lack of information exists about the benefits that a career in engineering holds and about which institutions such as TVET Colleges (in Soweto) are offering courses in engineering for students, as mentioned by one of the Business Studies participants. Learners are also not aware of the prerequisites, such as Mathematics and Science, to complete a course in Engineering. Some of the Business Studies and Hospitality participants encouraged that all-girl schools should be targeted for marketing purposes about engineering courses to inform young girls of the importance of subjects such as Mathematics and Science in the future. They feel that the greatest emphasis is currently placed on young boys when marketing is done for engineering.

5.5.4 Practical aspect of NCV

The participants of this study felt that the NCV programme provided some sort of basic or introduction to the three different courses that other programmes did not provide. This could be as a result of social burdens experienced at previous institutions such as secondary schools, where a vocation specific foundation in the desired course of pursuit is not catered for. These schools were also unable to provide for the practical aspect of the different vocations that these learners wanted to pursue; the NCV programme at the TVET institutions was finally able to make up for this social burden that these learners had to bear earlier in their lives. As

mentioned by Powell and McGrath (2014), TVET Colleges offer a better learning pathway or programme for learners.

5.6 Recommendations to attract women to study engineering at TVET Colleges

Three themes dealt with recommendations to attract women to study engineering at TVET Colleges. These were: Desire for equality; Addressing prevalent stereotypes, and the most prominent theme, Lack of information or education.

5.6.1 Desire for equality in the engineering pathway

As economies are growing, more and more women are entering the workplace. With some of the financial benefits that a career in engineering can offer, it should be a career that anyone could be interested in. However, the stereotype attached to engineering is that it is by and large considered a traditionally male occupation. The engineering participants in this study still encounter this stereotype in their field of study. They feel that they are viewed as incompetent, receive little or no support from peers, and are excluded from informal networks. This is also one of the reasons why women feel that they should continue in the face of the stereotype encountered. They display a strong desire for equality in this field, and this is what keeps them motivated to complete their studies in engineering.

5.6.2 Stereotypes

Participants felt that the stereotype suggesting that women are less capable than men to do engineering exists. This could also be a contributing factor as to why women are not readily attracted to these careers. The participants indicated that if more information was given to the public about what these engineering careers entail and that it is not limited to one gender, then existing stereotypes could be dismantled. If the stereotypes are dismantled, more women could be attracted to pursue careers in engineering. With regard to this, TVET colleges could better market the engineering brand to include and celebrate women on their online space and catalogues they create.

5.6.3 Lack of information or education

As the interviews were conducted with the participants, it became evident that a lack of information about what engineering entails (including the different courses that could be done in this discipline) constitutes a barrier and contributes to the underrepresentation of women in this field.

Lack of information on the different courses that could be studied at the various institutions of learning in South Africa is a reason why people do not enrol in these courses. A Business Studies participant indicated that she did not even know that SWGC, where she is currently attending, had a campus in Soweto that offers engineering related courses. Therefore, students are not aware of the different courses that are offered and just register for the NCV programme.

Lack of information concerning the pre-requisites for the various courses offered at these intuitions of learning are not clearly explained to the public as some participants claimed, and thus potential students fail to register for courses because they are under the impression that they do not qualify for the courses as was explained. Likewise, learners end up registering for the NCV programme but qualify for other programmes such as NATED programmes but they are not aware of it.

The participants suggested that successful women in the engineering fields should visit schools and community halls to tell their stories and inspire other women and young girls. This could build their confidence because if they see other women who are successful in the engineering field, they might be encouraged to do it themselves. They also indicated that if the media should portray engineering as something that women could be interested in, by adding pictures of female engineers, this could encourage more women to pursue these careers. TVET Colleges should regularly update their websites to ensure enough information about the different types of engineering courses at the various campuses are available to the public, these websites should state and update the pre-requisites required for the various courses.

5.7 Conclusion

In conclusion, change is needed and perceptions have to be challenged to allow women to pursue more than the quarter of STEM careers that they currently hold globally (Savaria & Moteiro 2017:92). From a South African perspective, if perceptions are challenged and change is brought about, more women could become the qualified artisans needed to support the economy and to alleviate the shortage of critical skills (Nzimamde 2013.) In the words of Mahatma Gandhi, we need to be the change we want to see in the world.

6 References

Akoojee, S, Gonon, P, Hauschildt, U., and Hofmann, C. (ed). 2013. *Apprenticeship in a Globalised World, Premises, Promises and Pitfalls.* Munster: LIT Verlag.

Anney, V.N. 2014. Ensuring the Quality of the Findings of Qualitative Research. *Journal of Emerging Trends in Educational Research and Policy Studies* (JETERAPS), 5(2): 272-281.

Applebaum, S.H., Audet, L., and Miller, J.C. 2003. Gender and Leadership? Leadership and gender? A journey through the landscape of theories. *Leadership & Organization Development,* 24(01):43-51.

Archer, L., Dawson, E., De Witt, J., Seakins, A., and Wong, B. 2015. "Science Capital": A Conceptual, Methodological, and Empirical Argument for Extending Bourdieusian Notions of Capital Beyond the Arts. *Journal of Research in Science teaching,* 2(07):922-948.

Baram-Tsabari, A. and Yarden, A. 2008. Girls' biology, boys' physics: evidence from free-choice science learning settings. *Research in Science & Technological Education,* 26: 75-92.

Baram-Tsabari, A., and Yarden, A. 2011. Quantifying the gender gap in science interests. *International Journal of Science and Mathematics Education*, 9(3):523-550.

Beaton, A.M, Tougas, N.R, and Monger, T. 2015. The psychological disengagement model among women in science, engineering, and technology. *British Journal of Social Psychology,* 54:465-482.

Bandura, A. 1982. Self-Efficacy Mechanism in Human Agency. *American Psychologist, 37*(2):122-147.

Bandura, A. (ed). 1995. *Self-efficacy in Changing Societies,* Cambridge: Cambridge University Press.

Bandura, A. 1997. *Self-efficacy: The exercise of control.* New York*:* WH Freeman.

Bandura, A. 1994. Self-efficacy. In V.S. Ramachaudran (ed.), *Encyclopedia of human behaviour* (Vol. 4, pp. 71-81). New York: Academic Press.

.

Bandura, A. 2001. Social Cognitive Theory: An Agentic Perspective*. Annual Review Psychology,* (52):1-26.

Bandura, A., and Adams, N.E. 1977. Analysis of Self-Efficacy Theory of Behavioural Change*. Cognitive Theory and Research,* 1(4):287-310.

Bandura, A., Babaranelli, C., Capara, G.V., and Pastorelli, C. 2001. Self-Efficacy Beliefs as Shapers of Children's Aspirations and Career Trajectories. *Child Development, 72*(01):187-206.

Bastalich, W., Franzway, S., Gill, M., and Sharp, R. 2007. Disrupting masculinities: Women Engineers and Engineering Workplace Culture. *Australian Feminist studies,* 22(54):385-400.

Bauman, H.J. 2020. A history of women in engineering education. *Technique*. Accessed 2 May, 2020 at: https://nique.net/life/2020/03/07/a-history-of-women-in-engineering-education/.

Betz, N.E., and Hacket, G.1997. Applications of Self-Efficacy Theory to the Career of Women. *Journal of Career Assessment,* 5(4):383-402.

Betz, N.E., and Hacket, G.2006. Career Self-Efficacy Theory: Back to the Future. *Journal of Career Assessment,* 14(1):3-11.

Betz, N.E., and Hacket, G.1981. The Relationship of Career-Related Self-Efficacy. Expectations to Perceived Career Options in College Women and men. *Journal of Counselling Psychology,* 28(5):399-410.

Betz, N.E., and Luzzo, D.A.1996. Career Assessment and the Career Decision-Making Self-Efficacy Scale. *Journal of Career Assessment,* 4(4):413-428.

Bhorat, H, Cassim, A., and Tseng, D. 2016. Higher Education, employment, and economic growth: Exploring the interactions. *Development Southern Africa,* 33(3):312-327.

Bix, A.S. 2004. From "Engineeresses" to "Girl Engineers" to "Good Engineers": A History of women's U.S. Engineering Education. *NWSA Journal,* 16(1):27-49.

Braun, V., and Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3 (2):77-101.

Bussey, K. 1999. Children's categorization and evaluation of different types of lies and truths. *Child Development,* 70(6):1338-1347.

Bussey, K., and Bandura, A. 1999. Social Cognitive Theory of Gender Development and Differentiation. *Psychological Review,* 106(4):679-713.

Bussey, K., and Bandura, A. 2004. On Broadening the Cognitive, Motivational, and Sociostructural Scope of Theorizing About Gender Development and Functioning: Comment on Martin, Ruble, and Szkrybalo (2002). *Psychological Bulletin,* 130(5):691-701.

Collins online dictionary, Available at: https://www.collinsdictionary.com/ Accessed, 28 November 2020

Cronin, C, and Roger, A. 1999. Theorizing Progress: Women in Science, Engineering, and Technology in Higher Education. *Journal of Research in Science,* 36(6):367-661.

Deutsch, F.M. 2007. Undoing Gender. *Gender & Society,* 21(1):106-127.

Dar-Nimrod, I., and Heine, S.J. 2006. Exposure to scientific theories affects women's mathematics performance. *Science,* 314:435.

Department of Education (DOE) 2007. FAQ'S: Introducing the new National Certificate (Vocational), Pretoria: Department of Education.

Department of Education (DOE) 2000/03. Report 191 Education Policy Norms and Standards. Pretoria: Department of Education.

Department of Education (DOE) 2006. Government Gazette no. 28677 Government notice no. 302. Pretoria: Government Press.

Denzin, N.K., and Lincoln. Y.S (eds.),1994. *Handbook of qualitative research*. Thousand Oaks: Sage Publications.

Deutsch, F.M. 2007. Undoing Gender. *Gender & Society,* 21(1):106-127.

Donaldson, S.I, Berger, D.E., and Pezdek, K.(ed). 2006. *Applied Psychology New Frontiers and Rewarding Careers.* London: Lawrence Erlbaum Associates, Publishers.

Eagly, A., and Karua, S.J. 2002. Role Congruity Theory of Prejudice Toward Female Leaders. *Psychological Review,* 109(3):573-598.

Eagly, A.H., and Wood, W. 1999. The Origins of Sex Differences in Human Behaviour. Evolved Dispositions Versus Social Roles. *American Psychologist,* 54(6): 408-423.

Eastman, C., and Marzillier, J.S. 1984. Theoretical and Methodological Difficulties in Bandura's Self-Efficacy Theory. *Cognitive Theory and Research,* 8(3): 213-229.

Ertl, B., Luttenberger, S., and Paechter, M. 2017. The impact of gender stereotypes on the self-concept of female students in STEM subjects with an under-representation of females. *Frontiers in Psychology,* 8, 703-713.

Fallan, L, and Opstand, L. 2016. Student Self-Efficacy and Gender-Personality Interaction. *International Journal of Higher Education,* 5(3): 32-44.

Fiske, T. 1993. Controlling Other People. The impact of power on stereotyping. *American Psychologist,* 48(6): 621-628.

Fogliati, V.J., and Bussey, K. 2013. Stereotype Threat Reduces Motivation to Improve: Effects of Stereotype Threat and Feedback on Women's Intentions to Improve Mathematical Ability. *Psychology of Women Quarterly,* 37(3):310-324.

Foster, V.X.N. 2005.Career Aspirations of Female Engineering Students at a FET Institution. Unpublished research dissertation. University of South Africa, Pretoria.

Fox, M.F, Sonnert, G., and Nikiforova, I. 2009. Successful Programs for Institutional Environment. *Research in Higher Education,* 50(4): 333-353.

Frehill, L.M., and Ivie, R. 2013. Increasing Visibility of Women of Color in Academic Science and Engineering: Professional Society Data. *New Directions for Higher Education,* (163: 7-21).

Gewer, A. 2009. Features of social capital that enhance the employment outcomes of FET College learners. Unpublished research report. Johannesburg. The University of Witwatersrand.

Gill, J., Sharp, R., Mills, J., and Franzway, S. 2008. I still wanna be an engineer! Women, education, and the engineering profession. *European Journal of Engineering Education,* 33(4):391-402.

Gläser-Zikuda, M., Hagenauer, G., & Stephan, M. 2020. The potential of qualitative content analysis for empirical educational research. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research,* 21(1).

Graham, L.P. 1997.A qualitative study of undergraduate women in engineering. Unpublished research thesis. Virginia Polytechnic Institute and State University.

Guba, E. G. 1981. Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Communication and Technology Journal,* 29(2), 75- 91.

Guba, E.G., and Lincoln, Y. S. 1994. Competing paradigms in qualitative research. In N.K. Denzin, and Y. S. Lincoln (eds.) *Handbook of qualitative research* (pp. 105-117*).* Thousand Oaks: Sage Publications.

Gumpertz, M., Durodoye, R., Griffith, E., and Wilson, S. 2017. Retention and promotion of women and underrepresented minority faculty in science and engineering at four large land grant institutions. PLoS ONE. https://doi.org/10.1371/journal.pone.0187285. Accessed on 25 June 2018.

Fredricks, J. A., Hofkens, T., Wang, M.-T., Mortenson, E., and Scott, P. 2018. Supporting girls' and boys' engagement in math and science learning: A mixed methods study. *Journal of Research in Science Teaching,* 55(2): 271–298.

Gupta, V.K., Turban, D., Wasti, S.A., and Sikdar, A. 2009. The role of Gender Stereotypes of Entrepreneurs and Intentions to Become an Entrepreneur. *Entrepreneurship Theory and Practice,* 33(2):397-417.

Haines, E. L., Deaux, K., and Lofaro, N. 2016. The times they are a-changing… or are they not? A comparison of gender stereotypes, 1983–2014. *Psychology of Women Quarterly,* 40(3): 353-363.

Hatmaker, D.M. 2013. Engineering Identity: Gender and Professional Identity Negotiation among Women Engineers. *Gender, Work, and Organization,* 20(4):382-396.

Hentschel, T., Heilman, M. E., & Peus, C. V. 2019. The multiple dimensions of gender stereotypes: A current look at men's and women's characterizations of others and themselves. *Frontiers in Psychology,* 10, Article 11:.

Herman, C. 2015. Rebooting and Rerouting: Women's Articulations of Frayed Careers in Science, Engineering, and Technology Professionals. *Gender, Work, and Organization,* 22(4):324-338.

Hill, T.P., and Rogers, E. 2012. Gender Gaps in Science: The Creativity Factor. *Mathematical Intelligencer,* 34(2):19-26.

Hyde, J.S, Fennema, E and Lamon, S.J. 1990. Gender differences in mathematics performance: a meta-analysis. *Psychological Bulletin,* 107:139-155.

Jackson, O.L., and Laanan, F.S. 2011. The Role of Community Colleges in Educating Women in Science and Engineering. *New Directions for Institutional Research,* (152):39-49.

Lin, N. 1999 Social Networks and Status Attainment. *Annual Review Sociology,* (25):467-487.

Lincoln, Y. S., and Guba, E. G. 2013. *The Constructivist Credo*. Walnut Creek: Left Coast Press.

Lodico, M.G., Spaulding, D.T. and Voegtle, K.H. 2006. *Methods in Educational Research. From Theory to Practice.* Thousand Oaks: Jossey-Bass

Marganson, V.J., Jones, M.P., and Major, D.A. 2010. *Understanding Women's Underrepresentation in Science Technology, Engineering, and Mathematics: The*

Role of Social Coping. The Career Development Quarterly, (59):169-179.

Mark, M.M, Donaldson, S.I, and Campbell, B.(ed). 2011. *Social Psychology and Evaluation.* London: The Guilford Press.

Mathews, M., Glencross, M.J., and Ketane, L.H. 2002. *Conceptual integration of some basic concepts in Physics and Chemistry among Science Foundation year students. SAJHE / SATHO,* 14(1):160-165.

Mbabaali D. (2018). Why are girls still few in science-related courses? Daily Monitor. Retrieved from https://www.monitor.co.ug/News/Education/-girls-science-relatedcourses-Physics-chemical-equations/688336-4719382-7l73unz/index.html. Accessed 20 October 2019.

Mbanguta, Z. 2002.Towards a new engineering education policy for South African Further Education and Training (FET) colleges: easy articulation to universities and technikons and recognition by the Engineering Professional Council of South Africa. *World Transactions on Engineering and Technology Education,*1(1):39-45.

McIlwee, J.S., and Robinson, J.G. 1992. Women in engineering: Gender, power, and workplace culture. Unpublished research report. State of University of New York Press, New York.

McMillan, J.H., and Schumacher, S. 2010. *Research in Education Evidence-based inquiry.* 7th edition. New York: Pearson.

Melrose, S. 2010. Naturalistic generalization. In A. J. Mills, G. Durepos, & E. Wiebe (Eds.), *Encyclopedia of case study research.* (pp. 191–193). Thousand Oaks, CA: Sage.

Mendick, H., and Moreau, M. 2013. New media, old images: Constructing online representations of women and men in science, engineering, and technology. *Gender and Education, 25(3*):325-339.

Milgram, D. 2011. How to Recruit Women and Girls to the Science, Technology, Engineering, and Math (STEM) Classroom. *Technology Engineering Teacher,* 71(3):4-11.

Multon, K. D., and Brown, S.D. 1991. Relation of Self-Efficacy Beliefs to Academic outcome: A Meta-Analytic Investigation. *Journal of Counselling Psychology, 38*(1):30-38.

Mujtaba, T., and Reis, M.J. 2014. A survey of psychological, motivational, family, and perceptions of physics education factors that explain 15-year-old students' aspirations to study physics in post-compulsory English schools. *International Journal of Sciences,* 12 (2): 371-393.

Musimenta, A., Adyanga, F. A., and Sekiwu, D. 2020. Gender and performance disparity in mathematics: A study of South Western Uganda. *African Educational Research Journal,* 8(4): 664-673.

Nair, S., Voklkova, V., and Abadjieva, T. 2000. Analysis of Gender Differences in Education for Engineering Career (Gaborone Case Study). *Botswana Journal of Technology, April 2000 :*1-8.

Ndlovu, V. 2017. The relationship between hardiness and career adaptability of students studying at Technical and Vocational Education and Training (TVET) Colleges in Gauteng. Unpublished dissertation report. The University of South Africa, Pretoria.

Nejad, E.H., and Khani, S.S. 2014. Studying the interaction of gender and self-efficacy [high and low] on the academic achievement of students in the third grade. *Bulletin of Environment, Pharmacology, and Life Sciences,* 3(2):67-72.

Nosek, B. A., Smyth, F. L., Sriram, N., Lindner, N. M., Devos, T., Ayala, A., Kesebir, S., et al. 2009. National differences in gender–science stereotypes predict national

sex differences in science and math achievement. *Proceedings of the National Academy of Sciences,* 106(26): 10593-10597.

Onwuegbuzie, A. J., and Leech, N. L. (2007). A call for qualitative power analyses. *Quality & Quantity,* 41(1): 105-121.

Powell, L., and McGrath, S. 2014. Advancing Life Projects: South African Students Explain Why They Come to FET Colleges. *Journal of International and Comparative Education,* 3(2):213-226.

Pope, C., Van Royen, P., and Baker, R. 2002. Qualitative methods in research on health care quality.*Quality Safety Health Care*, 11:148-152.

Ranson, G. 2005. No Longer "One of the Boys" Negotiations with Motherhood, as Prospect or Reality, among Women in Engineering. *CRSA/RCSA,* 42(2):145-166.

Research and Information System for Developing Countries (UNESCO). 2015. A Complex Formula: Girls and Women in Science, Technology, Engineering, and Mathematics in Asia. *Asian Biotechnology and Development Review,* 17(1):43-61.

Romm, N.R.A. 2001. *Accountability in Social Research*. New York: Springer.

Romm, N.R.A. 2018. *Responsible Research Practice.* Cham: Springer.

Rudman, L.A., and Phelan, J.E. 2008. Backlash effects for disconfirming gender stereotypes in organizations. *Research in Organizational Behaviour,* 28:61-79.

Saldana. J. 2016. *The Coding Manual for Qualitative Researchers.* 3rd edition, London: Sage.

Savari, S.S., and Mansor, N.B. 2013. A study of student's general self-efficacy related to gender differences. *International Journal of Informative and Futuristic Research,*1 (4):62-67.

Savaria, M., and Moteiro, K. 2017. A Critical Discourse Analysis of Engineering Course Syllabi and Recommendations for Increasing Engagement among Women in STEM. *Journal of STEM Education,*18 (1):92-97.

Saavedra,L., Araujo, A.M,Taveira, M.D.C and Vieira,C.C. 2014. Dilemas of girls and women in engineering: a study in Portugal. *Educational Review,* 66 (3):330-334.

Scott, D., and Usher, R. 1996. *Understanding Educational Research*. London: Routledge.

Sichangi, M. W. 2017. *Why are girls still few in science-related courses*? Association for the Development of Education in Africa (ADEA): Published on 10 February 2017.

Smeding, A. 2012. Women in Science, Technology, Engineering, and Mathematics (STEM): Stereotypes and Stereotypes' connectedness to Math Performance. *Sex Roles,* 67(11-12):617-629.

Stats SA. 2020. *Work and Labour Force*. http://www.statssa.gov.za/?page_id=737&id=1. Accessed on 20 October 2020.

Sonnert, G., and Fox, M.F. 2012. Women, men, and Academic Performance in Science and Engineering: The Gender Difference in Undergraduate Grade Point Averages. *The Journal of Higher Education,* 83(1):73-101.

Steele, C. M. 1997. A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist,* 52:613–629.

Steele, C.M. (ed). 2009. National differences in gender science stereotypes predict national sex differences in science and math achievement. *Proceedings of the National Academy of Sciences,* 106(26).

Steyn, J. 2013. *Assignment Writing.* Pretoria*:* Van Schaik Publishers.

Transcriber (2017). *Wikipedia.* Available at: https://en.wikipedia.org/wiki/Transcriber (Accessed: 20 November 2020)

Vogt, C.M, Hocevar, D., and Hagendorn, L.S. 2007. A Social Cognitive Construct Validation: Determining Women's and Men's Success in Engineering Programs. *The Journal of Higher Education,* 78(3):337-364.

Webb-Williams, J. 2014. Gender differences in school children's self-efficacy beliefs: Students' and teachers' perspectives. *Educational Research and Reviews,* 9(3):75-82.

Zimmerman, B.J. 2000. Self-Efficacy: An Essential Motive to Learn. *Contemporary Educational Psychology,* (25):82-91.

Zwane, J.V., Surujlal, J., and Dhurup, M. 2014. Relevance of Further Education and Training College Engineering Learning Programmes in the Apprenticeship Context. *Mediterranean Journal of School Sciences,* 5(23):990-998.

APPENDIX A

Interview Questions for participants studying engineering

Main Research Question: What are the reasons for the underrepresentation of female students in engineering studies at TVET Colleges?

Personal details

Age: …….

Highest grade passed: ……..

Sub-questions	Example question	Participant responses

What triggered the enrolment of female students for engineering studies a TVET College?	• Why did you choose to study engineering? • Were you influenced in any way by stereotypes that suggest that women are less capable than men to study engineering? • Do you think such stereotypes still exist in our society and if so, did they affect you in any way? • If you feel that these stereotypes exist, what can be done to eradicate them? • How did you develop a sense of your capacities? • Do you feel that gender stereotypes affected your sense of capabilities and if it did, how did you overcome these stereotypes? • How do you remember developing your sense of capabilities as a young girl,	

	did you feel you had the capabilities of pursuing a career in engineering back then? Explain • Why did you choose to study at TVET College? • Within the “family role” do you feel that your partner would have to take on some of the familial responsibility? • Do you feel that you have a “strong sense of self-efficacy”? If so, do you feel that it could have encouraged you to pursue a career in engineering? • How would you describe your personality?	

Why did the female students enrol in the NCV programme and how do they experience the practical aspect of this course?	• What was the highest grade passed for Mathematics and Science? • Why did you register for the NCV programme instead of the Report 191? • Do you feel that the TVET colleges focus too much on “productivity” and could better prepare its learners for family life and challenges they could encounter in the workplace? If so, how?	
Did these engineering students feel that they had to overcome social obstacles when deciding to enrol in the NCV programme?	• What are some of the social barriers that you encounter that you feel could contribute to the underrepresentation of women in engineering studies at TVET Colleges? • What platform do TVET Colleges provide or should provide in your opinion to encourage women to pursue these disciplines?	

What recommendations would the female students give to attract women to study engineering?	• What do you feel can be done to attract more women to study engineering and to pursue a career in this discipline?	

APPENDIX B

Interview Questions for participants studying hospitality or business.

Main Research Question: What are the reasons for the underrepresentation of female students in engineering studies at TVET Colleges?

Personal details

Age: …….

Highest grade passed: ……..

Sub-questions	Example question	Participant responses
Why did the female students enrol in the NCV programme and how do they experience the practical aspect of this course?	• What was the highest grade passed for Mathematics and Science? • How did your Mathematics and Science marks influence your choice of career to pursue? • Why did you register for the NCV programme instead of the Report 191? • Do you feel that the TVET colleges focus too much on “productivity” and could better prepare its learners for family life and challenges they could encounter in the workplace? If yes, how?	

Why are some female students not interested in studying engineering?	• Why did you register for business studies or hospitality? • Would you consider a career in engineering? Why not? Were you influenced in any way by stereotypes that suggest that women are less capable than men to study engineering? • Do you think such stereotypes still exist in our society and if so, did they affect you in any way? • If you feel that these stereotypes exist, what can be done to eradicate them? • How do feel about women studying engineering and pursuing careers in this discipline? • How do you remember developing your sense of capabilities as a young girl, did you feel you feel you had the capabilities or interest in pursuing a career in engineering back then? • Do you feel that you have a “strong sense of self-efficacy”? If so, do you feel that it could have encouraged	

	you to pursue a career in business or hospitality? • Within the “family role” do you feel that your partner would have to take on some of the familial responsibility? • How do you describe your personality?	

Did these students feel that they had to overcome social obstacles when deciding to enrol in the NCV programme?	• What are some of the social barriers that you encounter that you feel could contribute to the underrepresentation of women in engineering studies at TVET Colleges? • What platform do TVET Colleges provide or should provide in your opinion to encourage women to pursue careers in technical disciplines?	
What recommendations would the female students give to attract women to study engineering?	• What do you feel can be done to attract more women to study engineering and to pursue a career in this discipline?	